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A law has been passed by the New York state legislature, appropriating $30,000 for a topographical survey and map of the state, to be made by the State Engineer, co-operating with the Director of the United States Geological Survey. This appropriation of $30,000 is for the present year. Of this amount, $6,000 will be spent by the State Engineer for determining and marking town and county boundaries, and $24,000, with an equal amount from the U. S. Geological Survey (or $48,000 in all), will be employed in making a topographical map of the state, similar to those already made of Massachusetts and Connecticut. There will be 5,000 sq. miles mapped this year, on a scale of 1 mile to 1 in., with 20 ft. contours. This will be distributed over different parts of the state, including the Adirondack region.

The total length of railway lines in Europe in December, 1892, says the "Temps," was as follows, with the additions built that year:

	Total miles.	Increase in 1892, miles.
Germany.	27.130	316
France.	23,715	655
Great Britain and Ireland.	20,435	50
Russia and Finland.	19,420	85
Austria-Hungary.	17,540	655
Italy.	8,240	175
Spain.	6,330	155
Sweden and Norway.	6,150	160
Belgium.	3,315	62
Switzerland.	2,045	50
Holland and Luxemburg.	1,925	11
Roumania.	1,590	0
Portugal.	1,430	105
Denmark.	1,320	18
Turkey and Bulgaria.	1,074	0
Greece.	572	87
Servia.	337	0
Malta.	7	0
Totals.	142,575	2,584

The quality of the water supply of Chicago, according to press dispatches, has been investigated by commissioners sent by the London "Lancet," with a view of obtaining information to guide English visitors to the World's Columbian Exposition. The report states that the commissioners found the Chicago River in very bad condition; that analyses of water from Lake Michigan failed to furnish distinct evidence of serious pollution; that the lake water should be filtered, since not a single sample of the ordinary supply was entirely free of sediment, generally vegetable debris; that the use of impure ice, placed in the water, was a source of danger; and that all visitors should use no water which has not been boiled and filtered. As is generally known the Chicago water supply is taken from Lake Michigan.

The bridge over the Kistna River, at Bezwada, India, for the new East Coast Railway, was opened March 17, by Lord Wenlock, Governor of Madras. This important bridge is the largest in Madras, and has occupied over three years in construction. It consists of twelve spans of 300 ft., and the piers are of stone masonry. The East Coast Railway will eventually run from Madras to Calcutta.

An artesian well, on the Colorado desert, at Walter's Station, on the Southern Pacific Railway, yields 23,000 gallons of cool, fresh water every 24 hours. The well is 483 ft. deep, and the surface of the ground at that point is 195 ft. below sea-level. The water is supposed to come from below a heavy clay stratum, underlying this saline, depressed region, and leading up to some distant mountains. It is the most successful of a number of artesian wells sunk in the "desert."

The duplex compound "articulated" locomotives on the Mallet two-cylinder compound system were described and illustrated in our issue of Aug. 15, 1891. Six of these engines, with long boilers, and side tanks, were built by J. A. Maffei, of Munich, in 1891, for the Swiss Central Ry., and have proved so satisfactory that ten more are being built at the same works for that road. There are eight wheels, all drivers, but arranged in two separate groups, with independent frames. The two high-pressure cylinders are near the middle of the engine, driving the rear set of wheels, and the two low-pressure cylinders are forward of the smokebox. The Walschaerts valve gear is used. The engines have cylinders 13×25 and 22×25 ins.; driving wheels, 4 ft. 3 ins. diameter; heating surface, 1,251 sq. ft.; grate area, 19½ sq. ft.; weight in working order (with 11,000 lbs. of water and 4,400 tons of coal), 131,200 lbs.

The most serious railway accident of the week was the derailment of a freight train at the Buffalo Bluff drawbridge, near Palatka, Fla., on the Jacksonville, Tampa & Key West R. R., April 4. The draw is said to have been partly open, and the engineman disregarded the order to stop before reaching the draw. The engine and six cars went down, and three men were killed.

A bridge or trestle on the Louisville, New Albany & Chicago Ry., near Rossville, Ind., is reported to have given way under a passenger train April 8, the structure having been undermined by floods. Only the engine went down. One man was killed and another injured.

A locomotive boiler explosion occurred April 3 at Wilburton, Ind. Ter. The engine belonged to the Choctaw Coal & Ry. Co., and was standing awaiting orders to proceed with a passenger train. Four men were killed.

A sudden and heavy storm of wind and hail struck Chicago on April 7. The wind blew down two new hotels that had been erected for World's Columbian Exposition visitors, and also blew down the building for the Chattanooga cyclorama. The buildings, all frame structures, were not completed. The hail broke large numbers of windows, the damage being all confined to the South Side, near the lake. The same storm caused considerable damage in other parts of the state and in Michigan, and caused the crane accident noted below. At the same time a large wave from the lake entered the mouth of the Chicago River, and caused considerable damage to the shipping. One of the restaurant buildings on the Exposition grounds was twisted out of shape by the wind, but none of the main buildings suffered any damage, though the rainstorm proved that the roofs of many of them are by no means watertight, in spite of patching and repairs.

A serious accident occurred April 7 near Romeo, Ill., on Section 12 of the main channel of the drainage canal for the Chicago Sanitary District, by the overturning of a crane. According to information sent us the machine was a Brown hoisting cantilever crane, which was used for hoisting rock from the channel and dumping it on the spoil bank. The crane was 90 ft. high and had a reach of about 250 ft. It was constructed as a traveler, on four trucks, and moved along on two tracks. The men who operate the machine had taken out the blocks and had released the brakes and prepared to run the crane up to place, when a sudden and severe wind storm struck the crane with such force as to start it on the trucks and it moved bodily along the tracks for 150 ft. The engineman applied the brakes but without effect, as the wind was strong enough to slide the crane on the tracks when the wheels stopped. When it came to the end of the tracks the two end trucks ran off and the whole thing toppled over sideways. At the end of the track was a small coal house, in which several men had taken shelter from the storm. The crane fell over on this coal house and nine men were killed and six injured.

The increasing adoption of the American eight-wheel type of locomotive in Europe was noted in our issue of March 9, 1893. The "Railway Engineer" recently illustrated an inside cylinder engine of this type used by the London, Chatham & Dover Ry. for its continental steamboat expresses between London and Dover. The average speed is 46.2 miles per hour for 75 miles, with a maximum grade of 1%, and trains weighing 150 to 220 tons. The engines have cylinders 18×26 ins., driving wheels 6 ft. 6 ins. diameter; center line of boiler 7 ft. 2 ins. above the rails; boiler pressure, 150 lbs. per sq. in.; total weight, 94,080 lbs., with 64,624 lbs. on the drivers.

Ten-wheel locomotives are to be tried on the Irish narrow gage lines, and Neilson & Co., of Glasgow, are building six of these meter gage engines, with outside cylinders 13×20 ins., six driving wheels 3 ft. 6 ins. diameter, and a four-wheel leading truck.

The total cost of constructing 14,930 lin. ft. of 8-in. macadamized road in Montclair, N. J., in 1892 was $15,580, or an average of $5,906 per mile. The prices at which contracts were let were from 88 cts. to 98 cts. per lin. ft. for 8-in. road and 30 cts. per cu. yd. for excavation.

A tunnel under the Hooghly River at Calcutta, to connect the docks and city with the terminus of the East Indian Ry., at Howrah, on the opposite side of the river, is proposed by W. Duff Bruce and J. H. Greathead, engineers. Connection with the railway station is now maintained by steam ferryboats. The tunnel would be about 9,000 ft. long, about 4,000 ft. being under the river, with grades of 1.43% and 2%, and approach grades of 1%.

The city engineer of New Orleans, La., is ordered by the city council to prepare a comprehensive plan for the drainage of that city. This is to be done in connection with a topographical survey already ordered, and for which $17,500 is appropriated. Col. Geo. E. Waring, Jr., has been appointed consulting engineer.

The printing telegraph is to be introduced in France, and the Printing Telegraph & Construction Co. of the Agence Havas, has been incorporated in London to acquire the French patent for the latest improvements in printing telegraphs, and thereby in conjunction with the Agence Havas to construct the systems for the transmission of the news of the day to subscribers in France. The patent involves great improvements upon all similar instruments. Messrs. Assi and L. Genes, French engineers and experts to whom it has been submitted for examination, report as the result of their investigations into previous patents that the company's patent has not been anticipated, and is a valid patent in France. The new rapid printing telegraph from one central transmitting station will supply the news to all subscribers simultaneously, at a greatly increased speed. The new cabinet printing telegraph will supply stock exchange and general mercantile prices, racing news, and a synopsis of Parliamentary and general news, printed upon a page of seven words to the line. It is believed to be faster than any of the column printers now in use, and to cost 30% less, while, being attached simply by a wire inclosed in a silken cord, it can easily be moved about, like an electric lamp, to any part of the room. The Agence Havas states that no such instruments are at present in commercial use in France.

The acquisition of the street railways of London by the London County Council has been proposed, under the provisions of an act which permits the Council to acquire lines that have been 21 years in existence. The first line coming under this proposition is 4¼ miles, or about a third, of the London Street Tramway Co.'s line, for which the arbitrator, Sir Frederick Bramwell, M. Inst. C. E., has awarded the company $322,700, and this award is receiving the consideration of the company. According to the "Financial News," at present, with 13¼ miles of line, the company's property is capitalized at $177,900 per mile. For the 4¼ miles to be purchased, Sir Frederick Bramwell has awarded about $75,000 a mile, and with the two car barns the valuation is raised to $119,760 per mile. If the 68 horses, 649 cars, harness, and machinery, etc., belonging to this section, should be appraised at a sum bringing the entire price up to $655,000, the County Council would pay $154,115 per mile of fully-equipped street railway, and the company would be left with a reduced capital of $1,257,500, and nine miles of street railway, which would thus stand at $139,650 per mile.

An experiment is being tried at Huddersfield, England, of having letter-boxes affixed to all street cars, for the convenience of passengers. If a person stops a car to post a letter, a charge of 2 cts. is made by the street railway company. A somewhat similar plan has been in use in this country for some time, and several American cities have had the street railways recognized by the Postmaster General as U. S. mail routes.

THE LAKE BIWA, OR KIOTO-TU CANAL.

We are indebted to the courtesy of Prof. S. Tanabe, Professor of Civil Engineering in the Imperial University, Tokyo, Japan, for the interesting material here used in describing the Lake Biwa Canal, of which Professor Tanabe was the designing and constructing engineer. The description following is mainly taken from an address lately delivered by this engineer before the Engineering Society of Tokyo and from a translation furnished by the author.

A boat canal was proposed from Lake Biwa to the Bay of Osaka as long ago as the twelfth century of the Christian era, at the time when Kioto was the chief seat of government in Japan. But nothing was done in this direction until after 1868, when a political revolution transferred the seat of power from Kioto to Tokyo, the present capital. Since 1868, the creation of power at or near Kioto, and the consequent establishment of manufactories and the encouragement of navigation and commerce have been regarded as absolutely necessary to prevent the utter decay of the old capital.

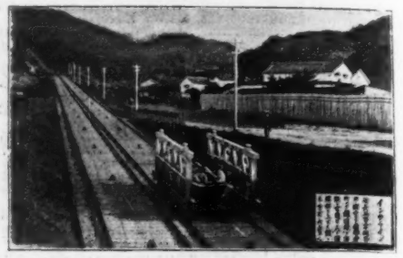
To the energetic ex-governor of Kioto, K. Kitagaki, is accorded the credit of inaugurating the work on the Lake Biwa Canal, which has for its several purposes the providing of power for city factories; the establishment of a line of canal navigation between the important Lake Biwa and Osaka Bay; the irrigation of rice fields, and, finally, a water supply for consumption and sanitary purposes in the city. The canal was commenced in March, 1885, and finished in April, 1890, under Mr. S. Tanabe, as Engineer-in-Chief.

This Lake Biwa is the largest lake in Japan; it covers 500 sq. miles and lies 280 ft. above sea-level, and is 35 miles from Osaka Bay. The new canal is 6⅞ miles long, and connects the southwest extremity of Lake Biwa with an existing waterway leading from Kioto to the Bay of Osaka; the difference in level in this seven miles, practically, is 143 ft. At the lake end the entrance to the canal is formed on land reclaimed from the lake by debris from the canal excavation, and extending about 1,000 ft. from the old shore; a breakwater protects this entrance. The first stretch of open canal is 28 ft. wide, 5 ft. deep and 1,800 ft. long, and leads to the first and principal tunnel. A regulating lock and sluice gate on this first section maintains a constant flow of 300 cu. ft. per second through the canal.

The tunnel through the Nagarayama range of hills is the longest in Japan, or 8,040 ft., about 1½ miles. It has a horse-shoe section, 16. ft. wide and 14 ft. high, providing for 6 ft. of water, and is tunneled through a formation of clay-slate, hornstone, sandstone and quartz; it is lined throughout with stone masonry and brickwork. There is no tow-path, as it is proposed to propel the boats by a chain lying on the bottom of the canal, somewhat after the French and German practice. The tunnel was excavated from a shaft, about 150 ft. deep, sunk at about one-third the distance from the west or Kioto end.

From the west end of the tunnel there is again about three miles of open canal (14,511 ft.), sometimes in cuttings and at others on embankment, but mainly skirting the hillside. Then come the range of the Hinooka-yama hills, requiring two tunnels of 411 ft. and 2,802 ft. length, respectively, running through a formation similar to that already described. Just below tunnel No. 3, about 5¼ miles from the intake, the canal divides into two branches. One of these, designed for navigation, descends about 118 ft. in 1,815 ft. to the level of the city. To overcome this descent of 1 in 15 an inclined plane is used, the boats being transported up and down on cradles on wheels hauled by wire ropes operated by water power from the canal above. From the foot of this plane there is a stretch of canal 60 ft. wide and 5 ft. deep, extending for 1¼ miles and joining the Kamogawa canal, an existing waterway leading to Osaka Bay. There is a lifting lock between them. The total length of the main canal is thus 6⅞ miles, with a fall of 1 in 2,000 to 1 in 3,000 in the navigable part; excepting the inclined plane, and the lower reach of canal at the head of the plane, which latter is almost level.

The second branch, at the head of the plane,

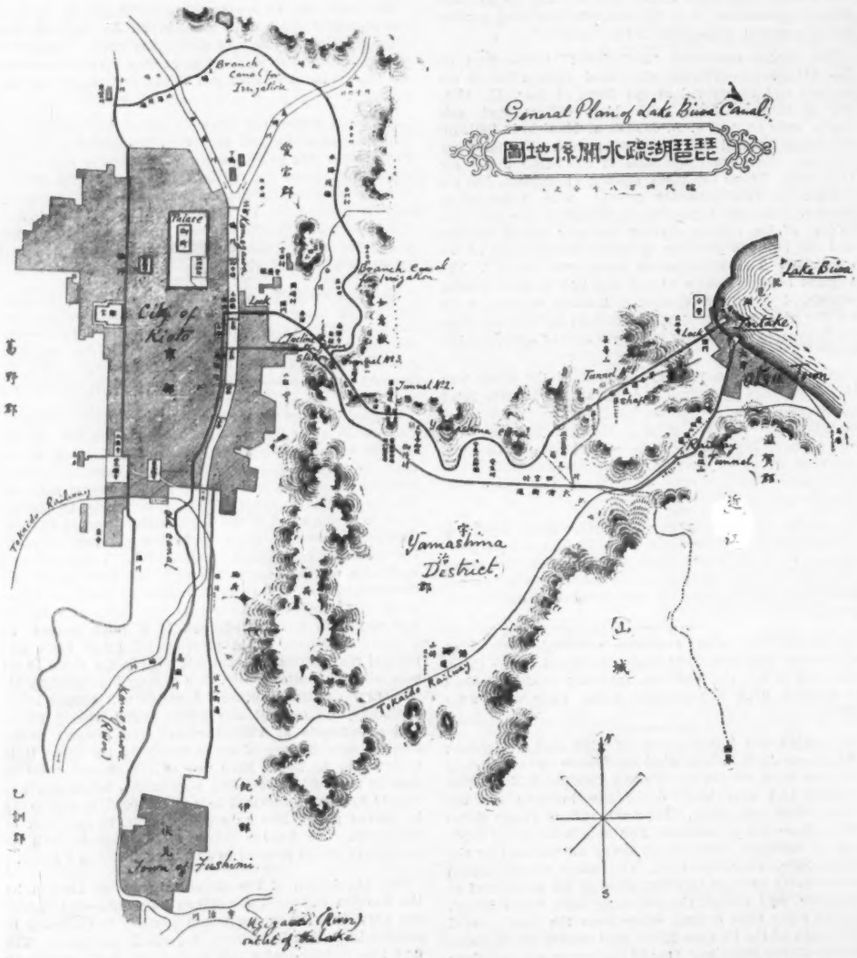


Inclined Plane; 118 ft. Lift, 1,815 ft. Long.

leads northwest through a small tunnel and winds along the sides of the hills. It crosses the Valley of the Imperial Tombs by a handsome aqueduct of 14 arches, and passing through another hill by two short tunnels it comes to the Takano and Kamo rivers and terminates at Kogawa, the north end of the city of Kioto, a total length of 5¼ miles. This branch canal only carries one-sixth of the water supply admitted from the lake, and the fall in some places is therefore as great as 1 in 100, the section being reduced; the least fall is 1 in 2,500.

The main object of the canal is really the production of power, and the dimensions and fall given to the waterway provide 250 cu. ft. of water per second, with about 120 ft. fall to be devoted to power production alone. It has been decided to use electricity as a means of distributing this power to distant points, the prime motor being water-wheels. The cost of the works was about 1,250,000 silver dollars, not including the cost of the power station, wheels, etc. Of this amount one-third was an imperial gift; one-quarter was in the form of a grant from the general government, and the remainder was raised by a tax on houses, trade and lands belonging to the 250,000 inhabitants of Kioto.

Among the original papers sent by Professor Tanabe is one in Japanese discussing the problems of inclines versus locks, the means of transferring boats from one level to the other, and the production and distribution of electric power. The author has considerately translated many of the items in this engineering report, and from these notes we find that it is proposed to use 120-HP. Pelton water-wheels, Edison dynamos and Sprague motors. The water is conveyed from the upper level of the canal to the power station by three lines of 36-in. pipe. We reproduce the general plan of the Lake Biwa Canal, with the translations as made thereon by Professor Tanabe; and also give some photographic views taken along the line of the canal, which show the excellent character of the work done under this Japanese engineer.



GENERAL PLAN OF BIWA CANAL; FROM JAPANESE ORIGINAL WITH TRANSLATIONS BY PROF. S. TANABE, ENGINEER-IN-CHIEF.

Entrance to Tunnel No. 1.

BRIDGES OVER NAVIGABLE WATERS OF THE UNITED STATES.

By Capt. W. M. Black, Engineer Corps, U. S. A.

What the navigable waters of the United States are has been settled by numerous decisions of the Supreme Court of the United States. In the "Daniel Ball" case (10, Wallace, 557), Mr. Justice Field, delivering the opinion of the court, states: "Those rivers must be regarded as public navigable rivers in law which are navigable in fact. And they are navigable in fact when they are used, or susceptible of being used, in their ordinary condition, as highways for commerce, over which trade and travel are, or may be, conducted in the customary modes of trade or travel on water, and they constitute navigable waters of the United States within the meaning of the acts of Congress, in contradistinction from the navigable waters of the states, when they form in their ordinary condition, by themselves, or by uniting with other waters, a continued highway over which commerce is, or may be, carried on with other states or foreign countries in the customary modes in which such commerce is conducted by water."

ENTRANCE LOCK, BIWA CANAL.

In the "Montello" case (20, Wallace, 430), Mr. Justice Davis, delivering the opinion of the court, says: "It would be a narrow rule to hold that in this country, unless a river was capable of being navigated by steam or sail vessels, it could not be treated as a public highway. The capability or use by the public for purposes of transportation and commerce affords the true criterion of the navigability of a river, rather than the extent and manner of that use. If it be capable, in its natural state, of being used for purposes of commerce, no matter in what mode the commerce may be conducted, it is navigable in fact, and becomes in law a public river or highway; vessels of any kind that can float upon the water, whether propelled by animal power, by the wind, or by the agency of steam, are, or may become, the mode by which a vast commerce can be conducted, and it would be a mischievous rule that would exclude either in determining the navigability of a river. It is not, however, as Chief Justice Shaw said (21, Pickering, 344): 'Every small creek in which a fishing skiff or gunning canoe can be made to float at high water which is deemed navigable, but, in order to give it the character of a navigable stream, it must be generally and commonly useful to some purpose of trade or agriculture.'"

The control of the navigable waters of the United States in all matters relating to the interests of navigation is vested in Congress by the clause of the constitution which delegates to Congress power "to regulate commerce with foreign nations, among the several states and with the Indian tribes."

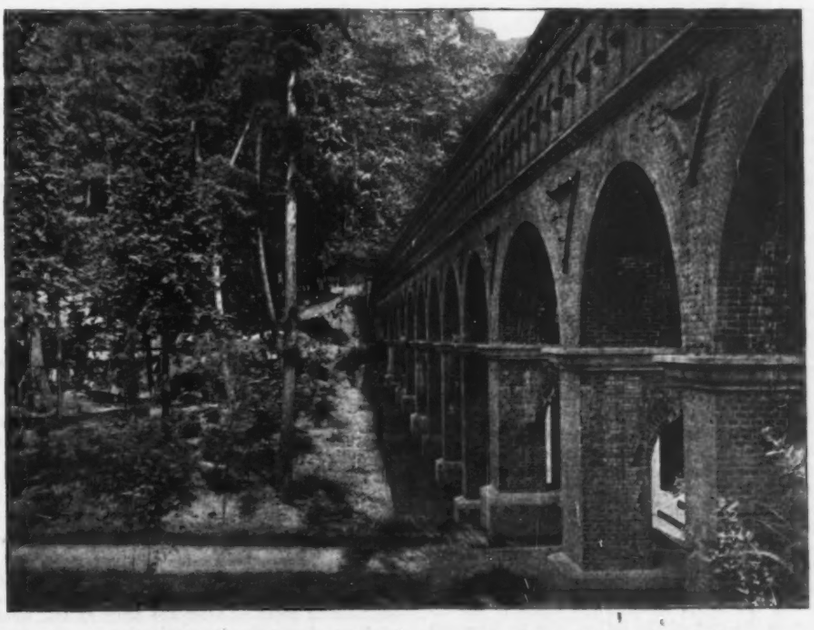
In the case of "Gilman vs. Philadelphia" (3, Wallace, 713), Mr. Justice Swayne, delivering the opinion of the court, says: "Commerce includes navigation. The power to regulate commerce comprehends the control for that purpose, and to the extent necessary, of all the navigable rivers of the United States which are accessible from a state other than those in which they lie. For this purpose they are the public property of the nation, and subject to all the requisite legislation by Congress."

The foregoing powers have been reaffirmed in numerous decisions, and under them authority to build bridges over the navigable waters of the United States has long been granted in special acts. The completeness of this power as relates to bridges is shown in the decision of Mr. Justice Bradley in the United States Circuit Court, district of New Jersey, Aug. 1, 1887, in the case of "Stockton, Attorney-General of New Jersey, vs. the Baltimore & New York R. R. Co. and others," in which he states that the power in this respect being supreme, and the act (granting authority to build the Arthur Kill bridge) in plain terms granting authority to build the bridge, the privilege is not promissory in its character, and may be exercised without the consent or concurrence of the states in which the structure is authorized by the act to be placed.

Though possessing full power, for many years Congress refused to take action in the case of bridges constructed under the authority of state law, wholly within a state. But this gave rise to so much litigation when the bridges proved obstructions to navigation, that in the first session of the Fifty-first Congress a general law was enacted to cover these cases. It is found in Section 7, of the act approved Sept. 19, 1890. Sections 4, 5, 6, 8, 9, 10 and 11 of the same act relate to existing bridges and other works which are or may be obstructions to navigation. Section 7 was amended in Section 3 of the act approved July 13, 1892.

Under these acts the Secretary of War is authorized and directed to cause such alteration of any existing bridges as he may deem necessary to render navigation under or through them "reasonably free, easy and unobstructed." Further, it is made the duty of officers and agents having the supervision, on the part of the United States, of the works in progress for the preservation and improvement of said navigable waters, and in their absence of the United States collectors of customs and other revenue officers, to enforce the provisions of the act by giving information to the District Attorney of the United States for the district in which any violation of any provision of the act shall have been committed.

In the case of new bridges authorized by state law to be built over waters lying wholly within a state, work or construction cannot be begun until after the location and plan of the bridge have been submitted to and approved by the Secretary of War. In all cases where the desired bridge is to be over waters not lying wholly within a state, the enabling act must be passed by Congress. Such an act either fixes the location and plan of the bridge, as far as navigation interests are concerned, or else provides that such location and plan shall be approved by the Secretary of War before work begins, usually specifying that the bridge company shall submit with the plans a map of the river for one mile above and below the proposed location, showing the location of other bridges, if any exist, the topography of the river banks, the high and low water lines, the direction and strength of the currents at all stages, accurate soundings of the bed of the stream, and such other information as the Secretary of War may require. These plans



AQUEDUCT, BIWA CANAL; ACROSS THE VALLEY OF THE IMPERIAL TOMBS.

are then usually referred by the Secretary of War, through the Chief of Engineers, to the engineer in charge of the district in which it is proposed to locate the bridge, or to a board of engineers for examination and report.

It may be taken for granted that in the plans as submitted, the interests of the bridge owners are fully looked after. It remains to be seen what the interests of navigation require. The location should be on a straight reach, with a single permanent channel for high and low water, having the currents directly perpendicular to the line of the bridge at all stages. The reach should be long enough to permit tows to straighten out and vessels and tows to direct themselves squarely toward the middle of the channel span before getting into dangerous proximity to the bridge. To this end there should be no other bridges or obstructions near it. If the bridge be in a city, the fairway of the approaches should be far enough from the bank not to interfere with vessels lying at the wharves, and far enough to permit the safe movement of boats from their slips.

With repard to navigation, bridges may be classed as high and draw bridges, i. e., those which permit free navigation beneath their spans, and those in which a span must be opened to allow a boat to pass. In examining the plans for a high bridge, the points requiring attention are location, position and length of channel span or spans, height of lowest member of channel span and number, size, shape and location of piers.

High bridges have the advantage of giving a broader channel span, of needing less channel space for their piers, and thus obstructing the flow less, and of giving a free passage at all times for traffic over and under them. One disadvantage is the increased cost of land approaches in almost all cases, and hence in the strong pressure to restrict the height below that required for all classes of vessels navigating the waterway at all stages.

The position of the channel span is fixed by the position of the channel. Should there be different channels for high and low stages there must be at least two channel spans. The length of the span must depend on the character of the commerce. Mr. C. Shaler Smith, writing of the requirements of Western river navigation, sums up the conditions governing the channel spans as follows: "The location should be such that there is a clear distance both above and below the bridge of 2½ boat lengths (longest boat in the trade) of straight current, and where this is the case, the span should be sufficient to allow the longest boat on the river to float through sidewise, and the longest and broadest tow fleet to go through at an angle of 30° with the line of the current. The location of the piers in this case should be such that the natural axis of the current is through the middle of the span, without reference to the deepest water. Where this is attended to, the normal action of the current will carry an unmanageable boat or tow through without danger. When the location cannot be made over a straight current, the principles which should govern are these: Ascertain the distance in the line of the bridge, between the axis of the current at the lowest navigable stage, and the same at the highest water, and add this distance to the length of span previously determined for a straight current."

The lowest member of the channel span must be at a height above the water which will permit free passage for all vessels using the waterway at all navigable stages, excepting such abnormally high stages as can be expected to occur so rarely that the closing of navigation will work little injury. This will, in turn, depend on the nature and volume of the commerce of the waterway. Outgoing vessels may be compelled to lower their topmasts at times, and river steamers their chimneys. This is a tax on commerce, and its necessity must depend on the relation which the annual cost of handling the masts or chimneys bears to the increase in the cost of the bridge, due to increased height, it being granted that the traffic by land and by water have equal rights. A full discussion of the height needed on the Mississippi River is found in the appendix of the report of the Chief of Engineers for 1878. The height of the lowest members of other spans is generally fixed by the channel span at a height above the highest stages sufficient to permit the free passage of drift and ice.

The number, position and shape of the piers must be so fixed that they will offer a minimum obstruction to the flow of the water. To this end they should be smooth. Their greatest length should be parallel to the axis of the current, and their ends of a proper shape. Ice breakers should be added where needed, and all precautions should be taken to prevent the formation of a gorge by ice or drift-wood. Where the direction of the current varies at different stages so as to make it oblique to the piers at times, it may be necessary to provide booms, or guide cribs, for the channel span piers.

De Bauve gives for the elevation of water surface due to an obstruction the approximate value

$$y = H\left(\sqrt[3]{\frac{L^2}{L'^2}} - 1\right)$$

in which y is the increase in height of water surface; H, the depth before obstructing the stream; L, the width of cross-section before obstructing the stream, and L' the width of cross-section after obstructing the stream. Since the volume of discharge must remain the same after obstruction, and the velocity is equal to the quotient of the discharge by the cross-section, when the discharge is known the increase in the velocity can be easily determined, and from this the approximate increase of head. Trautwine also gives approximate tables for this increase in his "Pocket Book." The scour to be expected may be judged from the increased velocity.

In crowded waterways no piers should be permitted, as they are always, to a greater or less extent, obstructions to navigation. In no case should riprap or other irregular obstructions be permitted to be used in any other part of the river channel. The use of draw-bridges should be permitted only where the traffic by water is light. Even in this case they are a source of frequent clashings. The right of way rests with the water-craft, and under the law, draws must be opened promptly at the approach of any boat. This rule rests, first, on the old principle that the waterways must be kept open, and that any land traffic over them is an intrusion; and, second, on the fact that land vehicles can always be stopped in a comparatively short distance and started without difficulty, while this is not the case with all classes of water-craft.

The increasing importance of land traffic, and the fact that commerce by water is now almost entirely in materials which will stand delay, is making this hitherto invariable rule unbearable, and new legislation is urgently needed, defining the relative rights of land and water traffic at those points in the great trunk railways where draw-bridges are unavoidable. A provision of this kind, relating to bridges over the Harlem River, is to be found in the act of Sept. 19, 1890.

The position of the draw-span is governed by the ruling conditions for the channel span of high bridges. As the clear openings of draw-bridges must always be limited, guides of ample length should be provided on each side of each draw opening. Where the current is gentle, the width of draw opening, in the clear, need not exceed one and one-half to two times the width of the broadest boat or tow using the stream. The height of the bottom member above the water surface should be sufficient to permit a free passage for all drift and ice and, if possible, for the smaller kinds of craft navigating the waterway. Ample arrangements should be provided for opening the draw promptly.

The duties of an engineer charged with the consideration of bridge plans are well stated by the late General Warren, in his report on bridging the Mississippi River, submitted in 1878, as follows: "It would be a simple matter to report that a bridge giving about 85 ft. clear space above high water, with spans of 500 and 600 ft. (which, in an engineering point of view are practicable), would offer no obstruction to navigation on the upper Mississippi, or elsewhere, where vessels are propelled by steam and not by sails, and thus meet the requirements of the act; but it is evident from the debate that the 'plans' which shall 'offer the least impediment to navigation' must be based not merely upon questions of engineering capabilities. These plans must be within limits of practicability as to cost, and be adapted to the place where needed, and to the service required of the bridge. The plans must, therefore make reasonable provisions for all the requirements of the case, and the presentation must be accompanied by the facts and other evidences of practicability and utility."

WORLD'S COLUMBIAN EXPOSITION.—VII.

Boiler Plant.

In consequence of the great amount of machinery which will be installed and in operation it was seen that a steam boiler plant of considerable capacity would be required, and various propositions were made and considered for the arrangements of this plant, as well as various methods of handling the coal and ashes in case of coal being adopted for fuel. To insure safety from any danger of explosion it was decided to adopt the water-tube type of boiler exclusively, and the specifications under which contracts were let called for a plant with 100,000 sq. ft. of heating surface, capable of evaporating 450,000 lbs. of water per hour into dry steam at 125 lbs. gage pressure (Eng. News, March 5 and May 12, 1892). As shown by the accompanying table, there will be 54 boilers, by eight different makers, aggregating 22,975 HP., and divided into 26 batteries. The fuel will be oil, as noted in more detail further on, with a pressure of 13½ lbs. at the burners when not working and a steam pressure of 125 lbs. The estimated consumption of oil is 9,000 to 12,000 gallons per hour, with an evaporation of 900,000 lbs. of water per hour. The arrangements for this plant were carried out under the direction of Mr. Frederick Sargent, who was Mechanical and Electrical Engineer, and his assistants, Mr. C. F. Foster and Mr. R. H. Pierce, who have been appointed Mechanical Engineer and Electrical Engineer, respectively, since Mr. Sargent's resignation in March.

Makers.	No. of boilers.	Total HP. boilers.
Campbell & Zell Co.	8	3,750
" " "	1	500
Heine Steam Boiler Co.	8	3,750
" " "	4	1,875
Babcock & Wilcox Co.	10	3,000
Abendroth & Root Co.	4	1,500
Stearns Mfg. Co. (Gill boilers)	4	1,500
National Water Tube Boiler Co.	4	1,500
Clanbrock Steam Boiler Co.	3	2,000
Stirling Boiler Co.	4	1,800
" "	4	1,800
Totals.	54	22,975

Oil Fuel Supply.

In regard to the fuel supply, coal, gas and oil were considered by the management. The former had the objections of occupying considerable space and involving dirty firerooms, which were serious objections, especially the latter, as the boiler plant will form a part of the exhibits, and will be of much interest to mechanical engineers and others. Various systems of coal and ash handling machinery were suggested, including chain conveyors and automatic stokers, overhead delivery from cars, overhead storage bins, etc., together with various methods for disposing of the ashes. The gas fuel was proposed to be piped to the boilers from a plant outside the grounds. Proposals were received, for coal and oil at prices given in our issue of April 9, 1892, and it was then decided to use oil for fuel. The contract was awarded to the Standard Oil Co. at 72½ cts. per barrel of 42 gallons, the company to deliver it daily by pipe line, or by tank cars in case of failure of the pipe line, into the storage tanks provided by the Exposition management.

The Standard Oil Co.'s pipe line from Lima, O., is tapped at Whiting, Ind., by a branch pipe line to the Exposition grounds, about 40 miles long, making a total distance of 240 miles for piping the oil. This pipe line has a delivering capacity of over 1,000,000 gallons per day, and the pumping station is at Whiting. For taking the supply from tank cars there is a 5-in. pipe, 150 ft. long, at the side of a railway side-track, with six 2½-in. branches to connect with the cars. The oil can be pumped from the cars to the storage tanks or direct to the oil stand-pipe. There are twelve cylindrical iron storage tanks, of 84,000 gallongs aggregate capacity, in six chambers in a brick vault. The floor is 5 ft. below grade, and the vault is 12 ft. deep, covered with earth, neatly sloped and turfed. In each chamber is a sump with steam connection for draining any water or oil. The oil is pumped to a stand-pipe of 1,100 gallons' capacity, by two Snow duplex pumps of

400 gallons' capacity per minute each, with cylinders 8×8½×10 ins., and in the pumping station is also a Jenney incandescent dynamo for lighting the station and plant. The stand-pipe is of seven rings of 3-16-in. steel, 5 ft. high and 2 ft. 6 ins. diameter, the total height being 35 ft. It has a 9-in. overflow pipe and a 5-in. outlet pipe connecting with the 5-in. pipe to the boiler house. This latter pipe is laid under ground, in a straight line, and, with a 2-in. steam pipe, is inclosed in a square box of 2½-in. timber. The following particulars are abstracted from an article in "Power," of New York:

It was naturally desirable to locate the oil tanks and machinery as far as possible fro mthe main Exposition buildings, and the extreme southeastern corner of the grounds, being also nearest the source of oil supply, was consequently chosen for the site. Different arrangements of the tanks and plant were made and discussed, but it was finally resolved, probably on account of the effect on the minds of the insurance committee, to construct the storage tanks and vaults, at least, as nearly as possible according to the rules of the Fire Underwriters' Association.

The storage tanks are each 8 ft. diameter by 25 ft. long, built of 3-16-in. boiler iron. They are 12 in number and contain a total of 112,500 gallons. The vault in which they are placed is about 72 ft. long by 68 ft. wide, the outside walls being of brick varying from 32 ins. thick at the bottom to 18 ins. at the top. The vault is divided by 19-in. brick partitions into six compartments, two tanks being placed in each compartment. The capacity of each compartment is over twice that of the tanks which it contains, so that should a fire, explosion, or other accident take place in any section, notwithstanding the rapid expansion of the oil with heat, the danger would be confined to the section in which it originated. The walls of the vaults were carefully laid up in full joints of Portland cement mortar, the floor is of Portland cement concrete 15 ins. thick, and the roof is constructed of steel I-beams with brick arches. The vaults were placed as low in the ground as the water of the soil would permit, and the earth is banked solidly around and covers the top to the thickness of one foot.

The pumps and machinery for the transmission of the oil to the boilers are located as near as possible to the vaults. The arrangement of the machinery and piping was very carefully made, so as to insure a constant supply to the boilers under any emergency. Plans were made and a contract was entered into with the National Supply Co., of Chicago, for the storage tanks, stand-pipe, pumps and other machinery, as well as all piping required for the complete equipment of the oil plant, and on account of its extended experience with fuel oil machinery, the work was largely left in the company's hands.

The oil is delivered to the storage tanks from the main pipe line from the relay station at Whiting, Ind., (a distance of about 40 miles). The storage tanks will be filled once a day by a representative of the Standard Oil Co. From the storage tanks it is pumped into a stand-pipe 35 ft. high and 30 ins. diameter, which is connected directly to the boilers, thus maintaining a uniform pressure on the burners. When the oil is delivered in tank cars it will be necessary to pump it from these into the storage tanks and thence into the stand-pipe. The storage tanks are carefully calibrated for the measurement of all oil delivered; and this is accomplished by measuring, each day, before filling the tanks, the depth of oil in each one.

In the oil-pump house, a small building located but a few feet east of the storage tank vaults, are placed the pumps and stand-pipe. Besides these also are two 40-HP. vertical boilers 42 ins. in diameter and 8 ft. high, a small feed pump, and a feed water heater, all for the operation of the plant. The oil pumps used are two duplex Snow pumps, each of a size sufficient for the work required at any one time. Each pump is arranged with a double suction connection, one from the storage tanks and one from the tank-car line, and also with a double discharge, to the stand-pipe and to the storage tanks. This is done so that either pump may be used independently to deliver oil to the boilers from the storage tanks, or to fill the storage tanks from the cars. There is also a suction connection to the pumps from the main line between the stand-pipe and the boilers, this being put in so that should any serious accident occur at the boiler house end of the line, the contents of the pipe can at once be pumped back into the storage tanks. The piping and valves are so arranged that either pump may be used for either service at any time. A by-pass is put in the delivery to the stand-pipe, and a quick-opening valve with a connection into the overflow which runs from the stand-pipe to the storage tanks is put in, so that should ignition or an explosion take place in the stand-pipe its contents can be immediately emptied into the storage tanks. A single 5-in. wrought iron pipe connects the stand-pipe with the boiler house, and this is laid in a straight line about 3,200 ft. long between the oil pump house and the center of the boiler house.

The oil-pump house is equipped throughout with automatic electric valves, furnished by the National Electric Valve Co., of Cleveland, O. These valves are applied to the oil pumps, regulating the level in the stand-pipe; to the boiler feed pump, regulating the level of water in the boilers; and to the dampers of the boilers in the oil station, regulated by the steam pressure. By this arrangement any variation in demand for oil at the boiler house is, in theory at least, responded to automatically at the oil plant.

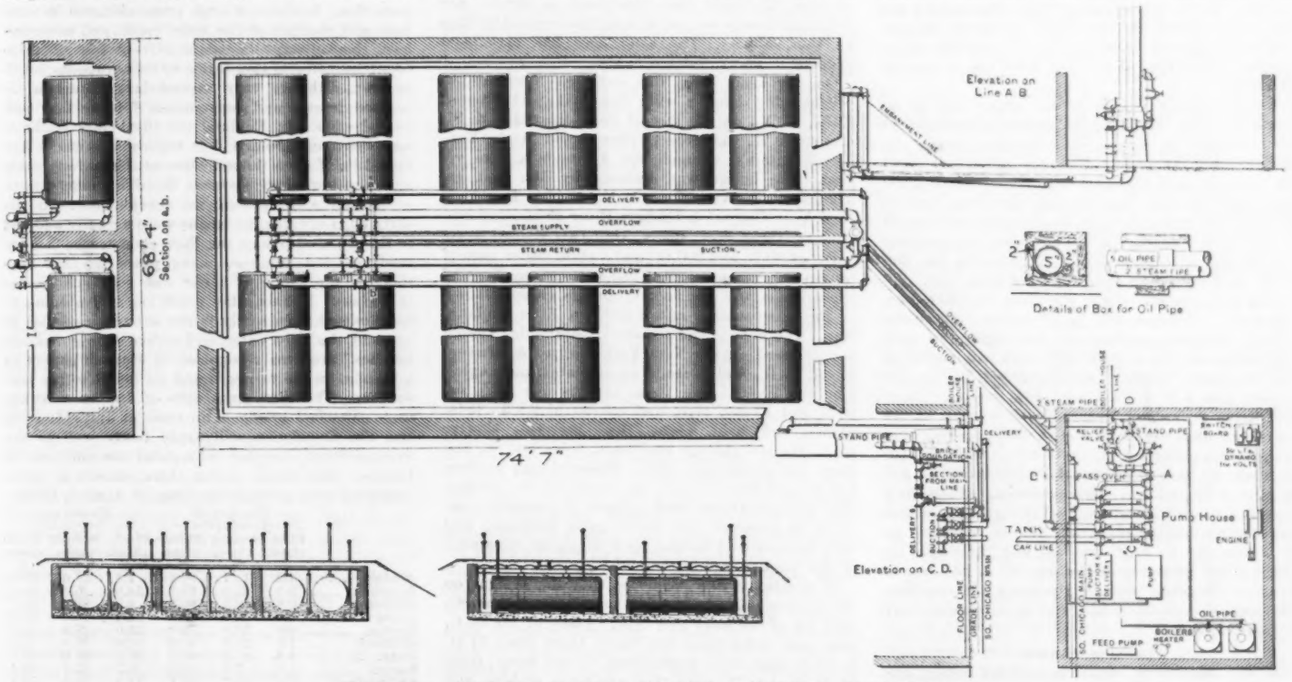
A 2-in. steam pipe is run parallel to the main pipe to the boiler house, and is laid in the same box with it. There is also a small steam coil of 1½ in. pipe placed in each storage tank. These pipes are necessary because, especially in cold weather, the oil is likely to become sluggish and very viscous, and is only liquefied by heat. The coils in the tanks are supplied with steam from the oil plant boilers, and the others will have a connection at each end, either of which may be used at will; at the boiler house the 5-in. oil supply branches, running in both directions down the boiler house, the pipe being laid in a heavy wooden box, covered throughout its length by removable cast iron plates. A branch is taken off the main line for each battery of boilers, and the burner connection is made from these branches.

Under the contracts for the boilers, each company has the right of selection of the burner to be used under its own make of boilers, the selection to be approved by the mechanical engineer of the Exposition. As yet, it is not decided what burners are to be used under all of the boilers. The Reed burners will be put on all of the Root and National boilers and on two of the eight Heine, the Armstrong burner on all of the four Gill (Stearns Mfg. Co.) boilers, the International on at least two of the Heine boilers. The Hydro-Carbon Co.'s burner will probably be also represented. The burners, however, for the Campbell & Zell, and the Babcock & Wilcox boilers are not as yet determined upon.

The burners will be set in various ways, and the construction of the furnaces, while in most cases on the same general principle, will vary in detail. On the National and Gill boilers the burners are placed inside the fire door, and all piping and connections are behind the boiler fronts, so that when the doors are closed, nothing is visible from the fireroom. The furnaces are so made that the air coming from the ash door openings passes to the rear of the furnaces, then through a horizontal passage to the front, where it comes in contact with the oil spray, becoming heated to a high degree before combustion takes place. In the National boilers the return passage is made up of flues made of firebrick, laid on edge, and which become almost white hot; and the furnace is made very deep, and with a concave arch at the rear. The burner is inclined slightly downward so that the flame is directed well into the arch, and the heat reflected back, and thus distributed as evenly as possible over the surface of the boiler tubes above. This construction is somewhat novel, and is a recent design of the National Supply Co.

In order to make the steam connections to the burners, a header of 2-in. pipe is run over each battery of boilers, and the burner connections are taken off from these. These headers are provided with separate 1½-in. connections to the boilers, independent of the main steam connections; and the headers over each battery are cross-connected by a 2½-in. pipe which runs the entire length of the boiler room, so that, if any boilers have been shut down they may be started up from any other boiler in the plant.

We learn from Mr. C. F. Foster, Mechanical Engineer of the Exposition, that the Campbell & Zell Co. will use the Reed burners; the Heine Boiler Co. will use the Reed, International, Burton and Greaves burners; the Babcock & Wilcox Co. will use the Gordon burners; Abendroth & Root Co., Reed burners; Stearns Mfg. Co. (Gill boilers), Armstrong burners; National Water Tube Boiler Co., Reed burners. All the important valves are



FUEL OIL STORAGE PLANT; WORLD'S COLUMBIAN EXPOSITION.

operated by electricity, and the supply of oil to the burners and water to the boilers is also regulated and automatically controlled by electrical connections, in accordance with the power required. There are also electrical connections to open or close the valves of the burners as the steam pressure falls or rises. Electric alarms are also provided to give warning of low water or excessive pressure.

The Ferris Wheel.

One of the interesting "side shows" on the Midway Plaisance will be the great steel wheel designed by Mr. G. W. G. Ferris, of G. W. G. Ferris & Co., engineers, of Pittsburg, Pa., which is to carry passengers in cars swung from the periphery. The wheel will be 250 ft. diameter, built up of structural iron, and the top will be 264 ft. above the ground. There will be practically two wheels, 28 ft. 6 ins. apart and connected by bracing. The steel axle is of enormous size, 33 ins. diameter, 45 ft. 2 ins. long, and weighs 89,320 lbs. Its cost was $35,000. It was forged by the Bethlehem Iron Works and shipped to Chicago on March 18. The axle is supported in bearings on steel towers 137 ft. high, and having four main columns, the two inner ones vertical, and the two outer ones inclined, with arched portal entrances and the usual bracing. Ample provision has been made for wind pressure on the wheel and towers. The towers are 50×40 ft. at the base and 5 ft. square at the top, and have masonry piers on pile and concrete foundations with a load of not over 2,000 lbs. per sq. ft. of base.

Between the two rims of the wheel will be 36 passenger cars, swinging on trunnion bearings so as to remain in their normal position during the revolution of the wheel. The cars will weigh about 19 tons, and each accommodate 60 persons, or 2,160 passengers in all. The landing platforms are arranged so that six cars can be unloaded and loaded at one time. Passengers will be given two complete revolutions, occupying about 20 minutes, the distance traveled being nearly a third of a mile.

The total weight of the structure is 4,300 tons, about 60% of which will be in motion. According to the published particulars the engines to turn this wheel will be of 2,000 HP., and will consist of two reversible engines, with cylinders 30 ins. diameter and 4 ft. stroke, with link motion. These will drive a train of gearing with wheels 12, 14 and 16 ft. diameter, with a steel chain passing over a cast steel pinion on the main axle. Only one engine will be used at a time, the other being for use in case of breakdown. The machinery will be in a chamber below the surface of the ground, where the electric lighting plant will also be installed, as it is proposed to light the cars and the wheel by about 3,000 incandescent lights. F. J. McCain & Bro., of Chicago, have the contract for erection. The total cost of this wheel and its accessories will be about $300,000.

Traveling Cranes.

In the Machinery Building and its annex are three overhead electric traveling cranes used for placing the exhibits in position, and these will be run to carry visitors during the time the Exposition is open, the tracks extending the entire length of the building, or a distance of about 1,300 ft. The steel structure carrying the tracks was built by the Edge Moor Iron Works, of Wilmington, Del., and the three cranes were supplied by the Yale & Towne Mfg. Co., of Stamford, Conn.; the Morgan Engineering Co., of Alliance, O., and W. Sellers & Co., of Philadelphia, Pa. The tracks are carried on plate girders of 25 ft. span, supported by steel A-frames, or columns. At the power plant the span is 50 ft., and special forms of columns are used. The rails weigh 60 lbs. per yd., and the heads are 21 ft. 3 ins. above the floor level. The columns support line shafting at a height of 15 ft. to supply power for the exhibits. These supporting structures, or runways, are designed for a load of 86,000 lbs. at each end of the crane, and a horizontal pull of 2,000 lbs. at each hanger for the line shafting, with a maximum fibre strain of 20,000 lbs. per sq. in. The cranes are of 75 ft. span, with a capacity of 20 tons, having each two hoisting trolleys of ten tons' capacity. For passenger service the trolleys will not be used, but the main "bridge" of each crane will be floored over and fitted with seats, railings and gates, and will run at a speed of about 300 ft. per minute. For handling exhibits in the work of installation the speed is about 500 ft. per minute. The Machinery Building was described and illustrated in our issue of June 30, 1892.

TRENTON FALLS BRIDGE; ADIRONDACK & ST. LAWRENCE R. R.

(With inset.)

Within the last few years there has been a decided tendency on the part of some of our larger railways to adopt solid floors, the ballast and roadway being continued on the bridge itself, instead of the usual style of floor, consisting simply of cross girders, stringers and ties. The first of these railways, and thus far the only one which may be said to have adopted the solid floor as a standard system of construction, was the New York Central & Hudson River R. R.; and in our issues of March 23, Nov. 16 and 23 and Dec. 7, 1889, we illustrated its application to several bridges of short spans. At that time this company had used the solid floor upon few if any bridges of more than 100-ft. span, but within the last three years the system has been used in the construction of several bridges of considerably longer span, and has been designed for the 400-ft. span swing bridge over the Harlem River, now being constructed. The New York, Providence & Boston R. R. Co. has also used the solid floor to a considerable extent, and in our issue of Oct. 27, 1892, we illustrated in detail the V-shaped trough section adopted for several bridges on this railway. The solid floor has also been adopted in many isolated cases.

On our inset sheet this week we illustrate in considerable detail a solid floor bridge at Trenton Falls, N. Y., on the line of the Adirondack & St. Lawrence R. R., recently constructed in the Vanderbilt interest through the Adirondack lake region. The bridge was designed by Mr. Geo. H. Thomson, M. Am. Soc. C. E., Bridge Engineer, New York Central & Hudson River R. R., and consists of three deck spans, viz., two riveted truss spans of 90 ft. and 200 ft., and a plate girder span of 60 ft. The composition of the various members of these spans and the floor system is clearly shown in the illustrations, and needs but little explanation. The floor is the standard rectangular trough section used on the New York Central & Hudson River R. R., and is made up of plates and angles. For the 200-ft. span these troughs are 12½ ins. wide and 13 ins. high, and consist of 3×3×⅜-in. angles and ⅜-in. plates. For the two shorter spans the troughs are shallower, being but 6⅜ ins. deep, and are 12 ins. wide. These trough sections are riveted direct to the top chords of the trusses. The floor is covered with a layer of asphaltic concrete to preserve the metal from moisture, and then covered with ballast, upon which the remainder of the track is laid in the usual manner.

In closing, it may be noted that the bridges on the Adirondack & St. Lawrence R. R. are practically all of the solid floor type. Those of the 10-ft. span and under have rail floors; those from 10 ft. to 34 ft. span have longitudinal trough floors; from 34 ft. to 100 ft. span they are plate girders, and from 100 ft. to 200 ft. riveted truss spans, with transverse trough floors. All of these bridges were designed under the direction of Mr. Geo. H. Thomson, to whom we are indebted for the matter from which our illustrations have been prepared.

PASSENGERS OF DIFFERENT CLASSES ON EUROPEAN RAILWAYS.

We have from time to time noted the steady, though slow, progress of the abandonment of the second class of passenger rates and accommodation on English railways. The Midland Ry, initiated this movement about 1878, but it was several years before any other roads followed its example, and it is within the last few years that the progress has been most rapid. About twelve railways have now taken this step, three having done so within the present year. On one of these latter, the Cambrian Ry. (Eng News, March 30), the number of second class passengers decreased 4,714 during 1892, and while in 1882 this class formed 6.8% of the total number of passengers, in 1892 it had been reduced to 3.72%. In 1892, also, the second-class traffic produced only 4 cts. per train-mile, against 61 cts. per train-mile for the third class. While on the more progressive lines the third-class cars are equally as well fitted as the second-class, there are many small old third-class cars still in service, specimens of which would be decidedly interesting exhibits at the World's Columbian Exposition. As there is, however, a tendency to provide better accommodation on English railways, it would seem better to level up instead of down, and to abandon the third class, or at least to adopt the nomenclature of first and second class, rather than the present awkward style of first class and third class. This view of the matter was expressed in an editorial on the three-class system in our issue of Aug. 11, 1892.

Some English saloon cars were described in our issue of March 23, and English railways are evidently beginning to realize that it pays to provide comfort and convenience beyond the rather rough accommodation which has caused so much grumbling from American travelers, who are used to comfortable traveling at home.

In other European countries there is little, if any, move toward a simplification of classes, but there is a growing tendency to add third class cars to express trains which have been hitherto mainly available for first-class and second-class passengers, and sometimes only for the former. From a report issued by the Minister of Public Works of France, we take the accompanying interesting table showing the percentage of the number of passengers by the three classes, and the percentage of receipts from these classes, in the principal European countries. It shows a large preponderance in numbers and receipts of the third class, yet, nevertheless, the railways in comparatively few of these countries cater to this traffic or encourage its development, although they expend large sums in increased luxury and convenience for the first and second class. In England the third-class traffic is now being encouraged, but mainly because it has forced itself upon the attention of the railway managers rather than because these managers have recognized and assisted its development. In the early days of railways means were actually adopted to throttle and reduce the third-class traffic in England, and it is not very many years ago that anything in the shape of a car was good enough for this class. In fact, this condition still obtains to some extent, principally in the suburban service of some of the lines entering London, whose "rabbit-hutches" are even recognized by English papers as a scandal to the railways and an insult to the passengers. The third-class cars of Italian railways were described briefly in an issue of July 14, 1892, and the description will apply fairly well to the average third class car throughout the continent of Europe. The fares of the three classes in these countries were given in our issue of April 2, 1892.

	Number of passengers.			Passenger receipts.		
	First class. %	Second class. %	Third class. %	First class. %	Second class. %	Third class. %
Austria.	1.2	12.7	86.1	7.5	27.6	64.9
Belgium.	3.9	12.8	83.3	14.8	25.1	60.1
Germany.	0.6	10.2	89.2	4.9	26.9	68.2
Great Britain.	3.6	8.1	88.3	12.4	10.6	77.0
France.	8.0	36.0	56.0	21.0	27.0	52.0
Holland.	7.0	23.0	70.0	16.6	36.2	47.2
Italy.	4.8	25.9	69.3	17.5	36.6	45.9
Russia.	1.4	7.1	91.5	6.2	15.1	64.1
Switzerland. ..	2.2	19.7	78.1	11.4	34.4	54.2

A SUBMERGED SEWER OUTLET, AT BINGHAMTON, N. Y.

A short length of submerged sewer outlet on the new State Asylum sewer was laid beneath the river at Binghamton, N. Y., in October, 1892. The sewer was 30 ins. in diameter, of cast iron with lead joints. There were four lengths of submerged pipe, each weighing about 3,500 lbs. The pipes were jointed on the shore, the ends stopped with wooden plugs, the pipe rolled into the water and brought within 1 ft. of position in the trench. The outer plug was drawn and the end of the pipe allowed to sink, after which the other plug was removed and the submerged section drawn up to and connected with the pipe already laid. The trench was from 5 to 6 ft. deep. The work was done in 12 hours.

This method of laying the pipe was adopted, in place of using a coffer-dam, because about 6,000 gallons of sewage per minute was flowing through the pipe already laid at the time the submerged section was put in place and because the river at this point had a loose, gravelly bottom.

The contractors for the work were A. H. Coon & Sons, Kingston, Pa. Mr. G. Bolton Coon, also of Kingston, had charge of the construction, and sent us the information given above.

FOUR-TRACK STEEL VIADUCT; NEW YORK CENTRAL & HUDSON RIVER R. R.

An extremely interesting piece of engineering work is to be carried out in New York, as noted in our issue of April 6, in the elevation of the four tracks of the New York Central & Hudson River R. R., along Park Ave., from 110th St. to the Harlem River, at 134th St., on a new four-track iron and steel viaduct, to replace the present tracks, which are partly on a masonry viaduct and partly in a cut with masonry retaining walls. The Park Ave. line is the approach to the Grand Central Station, at Forty-second St., New York, and crosses the Harlem River by a low-level drawbridge. A high-level drawbridge is to replace the present bridge, and the present grade will have to be raised to attain the higher elevation. South of 110th St. the line will remain unaltered, and is partly in tunnel. The work will be done under the supervision of the Board for the Park Avenue Improvement above 106th St., and Mr. Walter Katte, Chief Engineer of the New York Central & Hudson River R. R., is Superintending Eingineer for the Board. The viaduct will be a four-track structure of the plate girder type, with a solid floor of the type introduced by Mr. George H. Thomson, Bridge Engineer of the New York Central R. R., and used by him on a large number of bridges., including the truss bridge shown on our inset sheet this week. The plans for the viaduct have been prepared by Mr. Walter Katte, Chief Engineer, and Mr. George H. Thomson, Bridge Engineer, of the New York Central & Hudson River R. R. Proposals for the structure will be received by the Board for the Park Avenue Improvement until April 26.

The work under this contract will include everything above the base castings of the columns, with the exception of the rails and the track proper. It will be divided into four sections, with quantities as shown in the accompanying table:

	Sec. No. 1, 1,873 ft.	Sec. No. 2, 1,570 ft.	Sec. No. 3, 1,083 ft.	Sec. No. 4, 1,753 ft.	Total. 6,279 ft.
Columns, net tons....	332	330	285	361	1,308
Girders, "	1,720	1,450	1,000	1,575	5,745
Bracing, "	93	46	58	74	271
Floor system, "	2,659	2,200	2,645	2,740	10,244
Drainage pipes, lin. ft.	230	740	1,010	710	2,690
Gutters, galv. iron., lin. ft.	1,000	3,070	5,070	3,450	12,590
Railings, lin. ft.	2,360	...	...	...	2,360
Concrete, cu. yds.	12	36	33	41	122
Wheel guards (cast), tons.	10	30	22	33	95
Asphalt coating, sq. ft.	500	1,500	1,440	1,680	5,120

The track will be of the New York Central standard 100-lb. rails (Eng. News, March 19, 1892), resting on metal tie plates on the tops of the troughs and bolted through to the plates and troughs, no ties being used.

There will be three lines of longitudinal plate girders, supported on columns built up of angle irons and lattice bars. The structure will be mainly of deck spans, but in some places half-through and through spans will be used to give the required headway and maintain the grade of the railway. There will be no transverse girders, the continuous floor of transverse troughs obviating the necessity of such girders, and being connected to the longitudinal girders by heavy gusset plates.

All rivets will be ⅞-in. diameter, excepting those for the trough floor, which will be ¾-in. The maximum error allowed in the spacing of rivet holes is 1-32-in. for drilled, punched and reamed holes, and 2-32-in. for punched holes. The floor will be riveted up in the shop in sections not exceeding 8 ft., and the ends then faced up to precise plan lengths. The ends of the floor troughs will be closely cut out and matched to fit the stiffeners of center and side girders. The top and bottom plates of floor troughs on curves will be manufactured to radial lines, with edges sheared and then planed, or the plates may be cut "bias" in a planer. Holes ⅞-in. square, accurately spaced, will be punched on the top of each trough, and in the tie plates, for the bolts securing the track rails to the floor. Where tracks are laid on curves the rail plates, or tie plates, will be thickened under the outer rails and planed to the proper inclination for the superelevation of the rail. The tops of rail plates will be brought to the established grade elevations, so that the rails will bear equally on the troughs and be true to grade surfaces. The pocket in the foot of each column will be filled with Portland cement concrete, rounded off and coated on top with asphalt cement to discharge water outside of column. The concrete to be of best American Portland cement and clean, sharp, coarse bank sand, 1 to 1. The asphalt cement to be the Anchor brand asphalt roofing cement, made by the Warren Chemical Mfg. Co., of New York.

Each trough will be drained by heavy 1¼-in. gas pipe, screwed into the bottom plate, about midway between the side and center girders. These pipes will discharge into galvanized iron gutters weighing not less than 1½ lbs. per sq. ft., riveted with galvanized rivets and well soldered. The gutters will be 6 ins. wide and 4 ins. high, suspended from the solid floor by galvanized straps screwed to the ironwork at intervals of 30 ins. They will be continuous for the length of one span, with a fall of not less than 5 ins. in 100 ft. Generally they will be 5 ins. below the bottom plates of the floor, and run parallel with the line of the viaduct. At each center column the water will be drawn from the gutters with 4-in. wrought iron leaders, forming a Y, and a single 4-in. pipe will carry the water to a tile sewer placed below the top of masonry foundations. Cast iron wheel guards, made in two pieces, will be bolted to the columns. They will be dipped for five minutes in a bath of natural asphalt, coal tar and heavy oil at 300° F.

The steel will be made by the open-hearth process, from raw material within the Bessemer limit of phosphorus .1 and sulphur .05, and the finished material must not show more than .08 phosphorus, .06 sulphur and .40 manganese. Test strips, cut lengthwise, are to show an ultimate tensile strength of not less than 58,000 lbs. or more than 65,000 lbs., with an elastic limit of not less than 38,000 lbs. per sq. in. and an elongation of 28% and 24% in 8-in. lengths for plates under and over 36 ins. in width. Strips cut lengthwise, 1½ ins. wide, heated uniformly to a low cherry red and cooled in water at 82° F must stand bending double, and close down flat under the hammer without visible cracking. Rivet steel must possess an ultimate strength of not more than 54,000 lbs. per sq. in., and a reduction of area of 60%. Rivets heated to a red hot and upset for 3 ins. of metal must show (upon cutting out) no crystalline appearance. Wrought iron is to have an ultimate strength of 48,000 lbs. per sq. in., an elastic limit of 26,000 lbs. and an extension in 8 ins. of 15% along the grain and 80% of this across the grain. Rivet iron is to be soft, and to stand bending double cold, without fracture. All other wrought iron to bend 180° with an inner radius of 1½ times the thickness of the piece, without visible fracture. The cast iron is to be gray and tough, and the contractor must furnish test bars 1 in. × 1 in. and 5 ft. long, cast in sand molds from every heat. Such bars must sustain a test load of 500 lbs. suspended in the center, 4 ft. 6 ins. clear between supports. Both surfaces coming in contact will receive one coat of black mineral paint before being riveted together at the shop. All work is to receive one protective coat of black paint at the shop, and a finishing coat of black paint after erection.

Where the line is now on a four-track masonry viaduct, a double-track trestle will be built along each side of this viaduct to carry the traffic, while the old structure is being removed, and the new steel viaduct erected. The foundations for the center columns between 115th St. and the south line of 130th St., where the present line is in a cut with masonry retaining walls, cannot be built until the elevated structure is erected, and the railway traffic transferred from its present depressed roadbed to the new viaduct. As the center columns cannot, therefore, be erected until the rest of the viaduct is entirely completed, the line of center girders will be temporarily sustained upon timber trusses spanning the cut. After the traffic has been transferred to the viaduct, the track in the depressed road will be taken up, the foundations built for the center columns, and the columns erected after an interval of seven days to allow for the settling of the cement in the foundations and under the base castings. The contractor will be required to perform the work of erection without interfering with the railway, and must provide all erecting plant and falsework. Over the depressed part of the road, between 115th St. and 130th St., the center line of girders will be supported temporarily by timber trusses spanning the cut, as above stated, which trusses will be built and erected by the railway company.

Work is to be commenced by Sept. 1, 1893, and completed by March 1, 1894.

MUNICIPAL IMPROVEMENTS AT TOPEKA, KAN.

An interesting statement has been issued showing the extent and cost of work done under the direction of the city engineer during the last four years, from which we condense the particulars given in the accompanying tables and descriptive matter.

	1889.	1890.	1891.	1892.
Engineers' pay-roll.	$9,232	$8,350	$7,435	$8,059
Inspectors'.	4,051	1,825	1,895	2,452
Total paid engineers.	5,181	6,534	5,540	5,607
Str't commrs.' pay-roll.	32,718	35,943	37,873	39,535
Assessor's valuation.	$9,228,838	10,077,059	10,056,351	9,733,280
City tax, mills.	21.7	21.3	20.7	....
School tax, " .	8.5	8.5	9.5	9.8
State tax, " .	4.0	4.15	3.75	3.8
County tax, "	6.0	2.65	5.25	5.2
Total tax, " .	40.2	39.6	39.2	39.1
Permits for wat., gas or sewer conns.	975	756	625	586
Sewers.	$48,450	$1,353	$32,000	$62,380
Paving.	64,345	78,800	106,698	22,528
Total municipts.	150,825	114,540	152,995	100,690

Vitrified brick made at Atchison and at the Soldiers' Home, Leavenworth, were used for sidewalks in 1890, and some of Topeka's business men tested the clay west of the city and organized to develop it. In 1891 the Capital City Vitrified Brick & Paving Co., having established a plant with a capacity of 40,000 daily, commenced the manufacture of vitrified brick four miles west of Topeka, and obtained contracts for 60,000 square yards of brick paving. The brick proved the clay in this locality to be first class, and when properly burned makes the very best of vitrified brick.

The Kansas River rises 15 ft. from low to high water, and a survey made in 1892 showed the relative value of flow to be as follows:

	cu. ft. per sec.		cu. ft. per sec.
Aug. 4	2,462.2	Oct. 1	1,219.0
Sept. 21	1,606.4	Oct. 7	1,188.7
Sept. 22	1,595.0	Oct. 13	1,100.0
Sept. 27	1,391.8		

The contract prices for construction work ranged about as follows:

Asphalt paving, 1889-90	$2.80	per sq. yd.
Colorado sandstone paving, 1889-90	2.23	" "
lted cedar blocks on concrete, 1889	2.19	" "
Native blue limestone, 1889-90	1.40	" "
Vitrified brick paving, 1889-90, $1.69 and $1.68; 1891, $1.54 to $1.69; 1892, $1.28 and $1.69		" "
Colorado sandstone, curb, 1889-92	75 cts.	per lin. ft.
Colorado sandstone sidewalk, 1889	34 cts.	per sq. ft.
Vitrified brick sidewalk, 1889, 9 cts.; 1892,	6.6 to 7.8	" "
Pine plank sidewalks, 2-in.; 5 ft. 4 ins. wide	35¼	37¼ " "
Pine plank sidewalks, 2-in.; 4 ft. 6 ins. wide	36	" "
Pine plank sidewalks, 1-in.; 5 ft. 4 ins. wide	21¼	" "
Cement sidewalks; 1889, 2-in., 23 cts.; 3-in.	28	" "
Crosswalk stone	6¾	" "

Sewers, 1892:

Earth excavation	$0.25	per cu. yd.
Loose rock excavation	.45	" "
Solid rock excavation	3.10	" "
Concrete	3.50	" "

Pipe:
6-in., 25 cts.; 9-in., 32.5 cts.; 12-in., 44 cts. per ft.
15-in., 57 cts.; 18-in., 75 cts.; 21-in., $1. "
24-in., $1.50 "

Brick:
27 × 35 ins., 2-ring, $2.24; 27 × 35 ins., 3-ring, $3.75; 30 × 39 ins., 2-ring, $2.50; 33 × 43 ins., 2-ring, $2.65; 36 × 46 ins., 2-ring, $2.86; 38 × 50 ins., 2-ring, $3.08; 41 × 54 ins., 2-ring, $3.28; 44 × 58 ins., 2-ring, $3.50; 54 × 71 ins., 2-ring, $4.10; 54 × 71 ins., 3-ring, $6.40.

Inlets	$13.75	each.
Manholes	48.35	"
Catch basins	37.95	"
Lumber	$25	per M., B. M.
Brick in underdrain	$18	per 1,000

The city was laid out in 1854, incorporated in 1857, and made the state capital in 1861. Population in 1860, 759; in 1870, 5,790; in 1880, 15,527; in 1890, 31,800. Area, 3,962 acres. Elevation, 900 to 980 ft. above the sea. There are 106 miles of streets and about 175 miles of sidewalks. There are 37.67 miles of sewer, draining 1,162 acres, with 417 manholes; 186 storm-water catchbasins, and 157 inlets. The sewers carry off most of the storm water; they have cost $396,727, and bonds to the amount of $324,226 have been issued to pay for them.

Paving was commenced in 1887. There are now

193,810 sq. yds. of asphalt on 6 ins. of concrete; 34,445 sq. yds. of red cedar blocks on concrete, 3,520 sq. yds. of white cedar blocks on the viaduct, 51,642 sq. yds. Colorado sandstone, 10,578 sq. yds. native blue limestone, 75,548 sq. yds. of vitrified brick—altogether, 369,543 sq. yds. of paving; making 6 miles of asphalt, 3.6 miles of vitrified brick, 1.3 miles of Colorado sandstone, 1 mile of red cedar blocks, and 0.4 mile of native limestone paving. There has been laid by the city about 11 miles of brick sidewalk.

Grading, curbing and paving have cost $1,047,430. Special improvement bonds have been issued to the amount of $1,367,475. Of this sum, $550,432 has been paid, leaving $817,043.40 outstanding against specific property. The bonded indebtedness of the city at large is $337,000, together with outstanding school bonds amounting, June 30, 1892, to $243,202.

The Topeka Ry. Co. has a well equipped Thomson-Houston electric plant, with 30 miles of street railway, 40 motor cars, and a central station with two engines of 250 and 500 HP. Mr. Lewis Kingman is City Engineer, and John P. Rogers and W. H. Barnes, assistant engineers. Mr. Furman Baker is Street Commissioner.

THE NEW DAM FOR THE WATER-WORKS OF SANTA FE, N. M.

An earth dam 85 ft. high and over 1,000 ft. long is now being built by the Water & Improvement Co., of Santa Fe, N. M., for the water-works of that city. We are indebted for the accompanying description and illustrations of this structure to a paper recently read before the American Society of Irrigation Engineers, at Denver, by Mr. E. F. Hobart, Surveyor-General of New Mexico, and to Mr. J. M. Howells, Consulting Engineer, of Chicago, Ill., who is the engineer of the dam.

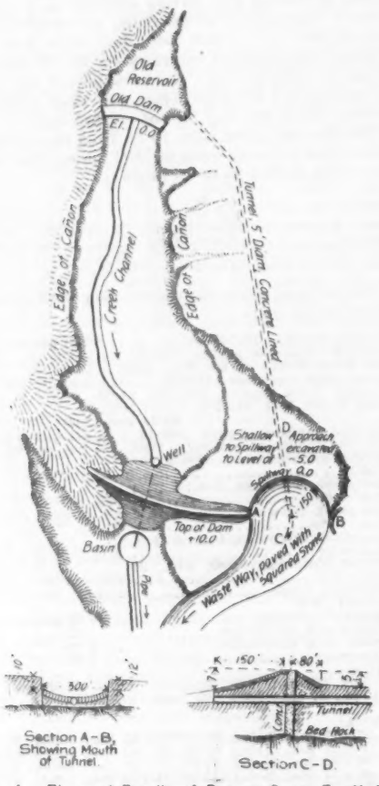


Fig. 1. Plan and Details of Dam at Santa Fe, N. M.

The dam is being built across the Rito de Santa Fe, two or three miles from Santa Fe. This stream heads in the mountains, and is fed, in part, by melting snow.

The plan and location of the dam is shown by Fig. 1, its cross-section by Fig. 2, and the work in progress by the view, Fig. 3.

The upper half of the dam site was excavated to rock, and the rock washed with water by means of hose.

The general character of the structure is shown by Fig. 2. The triple sheeting inserted in and carried above the concrete trench and heart walls consists of three thicknesses of 1-in. boards, nailed together horizontally. Hydraulic cement was used for the concrete.

The upper half of the dam is puddled in layers, a herd of 115 goats having been bought expressly for puddling. These goats are in charge of a herder, who keeps them in motion when on the dam, which is stated to be from 12 m. to 1 p. m., and from 5 to 6 p. m. each day. Fig. 4 shows the goats at work.

The intake chamber will be built of rubble masonry, with gates at different levels to permit water to be drawn just below the surface at all times. The gates controlling the supply to the city will be located below the dam.

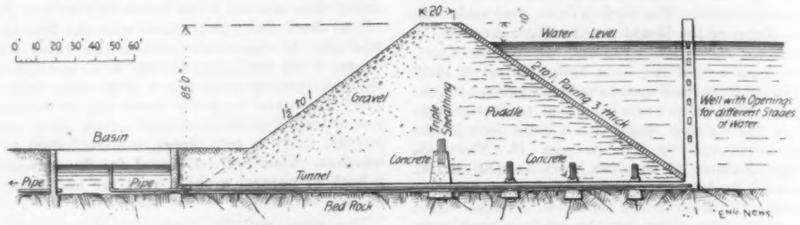


FIG. 2. CROSS-SECTION OF DAM AT SANTA FE, N. M.

The outlet pipes from the dam will be inclosed in an arched concrete conduit following the bed of the old stream, as shown in Fig. 1. This conduit is shown in Fig. 4. It is in the form of a semicircle, 8 ft. in diameter, resting on side walls about 1 ft. high. When the dam is completed, the upper 6 ft. of the conduit will be filled with concrete. Two 10-in. cast iron pipes will extend through the conduit, and a 16-in. pipe may be added later.

The outlet pipe turns up and discharges as a fountain into a basin, as shown in Figs. 1 and 2. The level of the basin is about 250 ft. above the city plaza.

The present water supply of the city is taken from the upper reservoir, shown in Fig. 1, the arched conduit, as we understand it, having been built to inclose the old supply main.

A 5-ft. circular tunnel, through rock, part or all of it lined with 7 to 12 ins. of concrete, will be provided to convey water from the old reservoir and discharge it below the overfall of the spillway of the new dam. This tunnel is designed to convey the natural flow of the stream below the new dam, when desired below or when muddy. Mr. P. E. Harroun, of Santa Fe, is Assistant Engineer of the work.

FIG. 3. SANTA FE DAM UNDER CONSTRUCTION, LOOKING DOWN STREAM.

THE BLOCK SYSTEM OF REPAIRING STREETS AT NEWTON, MASS.

An interesting experiment in connection with repairs and maintenance of the streets at Newton, Mass., most or all of which, it appears, are macadamized, was made in 1891, under the direction of Mr. Albert F. Noyes, City Engineer. From Mr. Noyes' report for the year 1891, just at hand, we abstract the following: In accordance with the instructions of the highway committee Mr. Noyes made a report on the method of maintaining macadamized roads in France, which report is appended to his annual report. This was followed by a classification of the streets of the city into principal and secondary and country roads. Of the class designated as principal streets, 22.4 miles, including 442,082 sq. yds. of surface, were selected and divided into ten sections varying in total area from about 28,000 to 80,000 sq. yds., the idea being to make the actual labor required in each division as nearly equal as possible.

The operation of this system of street maintenance can be best described by quoting from the report, as follows:

The men assigned to each section were selected from the most reliable and efficient men on the force and were called section men, and remained under the charge of the district foremen. Their duty was to keep their section in proper condition; that is, to keep the gutter clean of weeds, trim the grass, patch all gulleys and ruts in the roadbed, look after the sidewalks, etc.; in fact do all the small repairs necessary as soon as needed, the regular street force being called upon only for large repairs and renewals of the roadbeds, etc.

They were not to be called off from their regular work except in emergencies, such as snowstorms, etc., when the entire force is needed clearing the roads. Each man was supplied with a wheelbarrow, a pick, a shovel and a wooden rake, hoe, lantern, sickle, edging knife and cord line. The wheelbarrows were painted blue, with the section number clearly painted on the handle, so as to be easily seen by the foreman or superintendent, when on the rounds of inspection. At convenient places on each section piles of crushed stone and gravel were located, from which material was obtained for patching up whatever holes or ruts might appear in the roadbed or in the sidewalks. The other streets were cleared up at stated intervals by the rest of the highway force. Where large repairs were to be done or streets resurfaced, the whole force (outside of the section men) was joined together under the local district foreman, and the work carried rapidly forward to completion. In this way the repairs were made, as shown on the table of highway widening and reconstruction, at considerable less time and expense than if carried on simultaneously by the separate district forces.

The improved appearance and condition of the streets thus cared for was quickly noted by citizens. The men appeared to take a pride in their work and their efforts were attended with nearly equal results considering the varying conditions, namely, the original condition of the roadbed; level or hilly streets; stone curbing or sodded edging; concrete or cobble paved gutters, amount of traffic, etc.

A large plant for the manufacture of heavy ordnance is said to be projected at San Francisco, by Mr. Irving M. Scott, President of the Union Iron Works, the builders of the "Charleston," "San Francisco" and "Monterey" for the U. S. navy.

FOUR CYLINDER SIMPLE LOCOMOTIVE.

A locomotive of somewhat novel design has been built by R. & W. Hawthorn & Co., of England, under the patents of Mr. F. C. Winby, by whom the engine will be exhibited at the World's Columbian Exposition. The engine is of the eight-wheel or American type, intended for heavy express service. It has two pair of driving wheels, 7 ft. 6 ins. diameter, which are not connected by coupling rods. The forward driving wheels are driven by inside cylinders, 17×22 ins., and the rear or trailing wheels by outside cylinders, 16½×24 ins., placed forward on the frames, and having unusually long piston rods. With this arrangement there will be eight exhausts to a revolution, which would seem to call for an appliance for admitting air to the smokebox when working heavily in order to prevent the fire from being torn to pieces by the draft. The boiler and firebox are of considerable size, and the latter has a very large grate area. The boiler is of steel, with brass tubes, and the firebox is of copper. A large dome is fitted, also the Ramsbottom duplex safety valve generally used on English locomotives, and the smokestack is short and of large diameter, extending down into the smokebox, with a petticoat over the exhaust pipe.

The valves of the inside cylinders are operated by a link motion and valve gear, while those of the outside cylinders are operated by the Joy valve gear. The valves of all four cylinders are controlled simultaneously by a combined hand and steam reversing gear. The cab is said to be more complete than is usual in English locomotives, resembling the pattern used on the Northeastern Ry., which, however, are without seats, as noted in our issue of March 9. The principal dimensions are as follows:

Cylinders, inside (2)	17	× 22	ins.
" outside (2)	16½	× 24	"
Driving wheels (4), diam	7 ft.	6	ins.
Truck wheels (4), "	4	" 0	"
Wheel base, driving	11	" 4½	"
" " total	23	" 8	"
Length over buffers and footplate	32	" 6	"
Weight of engine	120,000		lbs.
Heating surface	2,000		sq. ft.
Grate area	28	"	"
Boiler pressure	175 lbs.	per	sq. in.

According to the published statements this engine is intended "to prove to Americans the "fallacy" of the compound system, but as the economy of this system (in two, three and four-cylinder engines) has been proved by hundreds of locomotives of various types and in all classes of service in this country it is not likely that this new engine will have much effect in this direction. The advantage of the compound system is in doing work with a saving of fuel and water consumption over that of a simple engine, and with little extra cost of maintenance and repairs. This advantage is obtained to best effect in heavy freight service at comparatively low speeds, although the highest speed ever attained on a railway has been attained by a compound locomotive (Eng. News, Dec. 8, 1892).

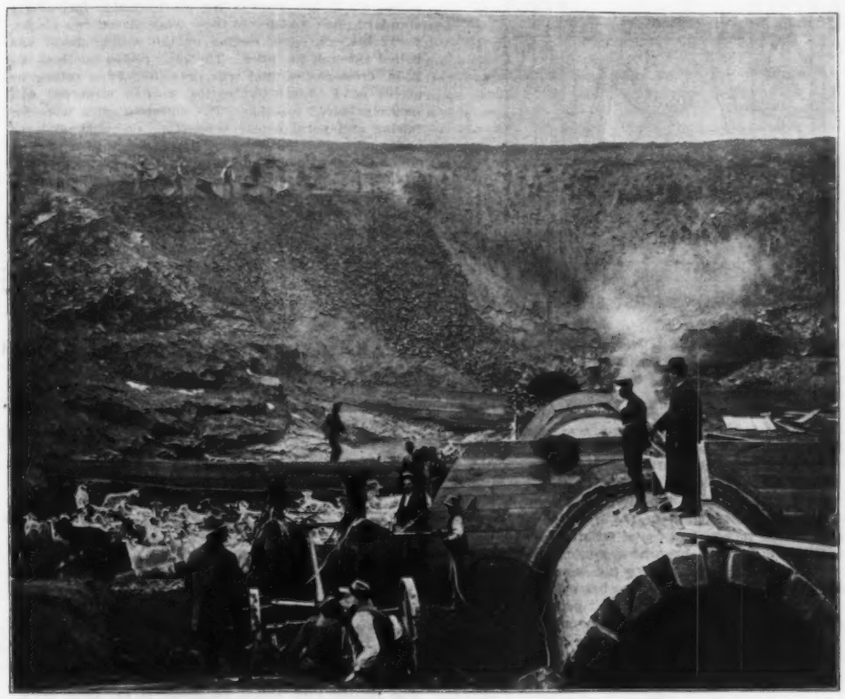


FIG. 4. SANTA FE DAM, SHOWING GOATS USED IN PUDDLING.

ELEVATING A 24-IN. GAS MAIN.*

By J. B. Crockett, President San Francisco Gas Light Co.

What is now known as the Potrero station of the San Francisco Gas Light Co. was built from 1869 to 1871. It is situated on the shore of the bay, and is bounded by Georgia, Humboldt and Sierra Sts. on the land sides. The situation of the plant is favorable with one exception,—that the extreme southern part of the city is isolated from the large gas consuming districts by water-ways and marshes, extending westward far into the city. To provide an outlet for the gas made at these works, and avoid crossing Channel Creek or the mud flats which mark the former boundaries of old Mission Bay, it became necessary to lay a 24-in. cast iron main from the works to a point crossing Kentucky St., at Solano St., thence over the high hills to the west Mission St., and thence in a northerly direction down the hill to the marsh at Santa Clara Ave.

The pipe was laid beneath the surface of the marsh on Santa Clara Ave., from Missouri to DeHaro Sts., a distance of 1,242 ft., then in a northerly direction, 510 ft., to Center St. From Center St. the large main enters the heart of the city through Ninth St., and is there connected with the ramification of pipes which supply the city with gas. Where the pipe crosses the marsh on Santa Clara Ave. it was laid with about 3 ft. cover of earth, and to all appearances on as good foundation as many other gas mains in the city. At this place the ground was below the official grade, from 2 ft. at the highest to 18 ft. at the lowest points; but at the time the pipe was laid no other nor more desirable location was available, nor could the ultimate grading of these streets be anticipated. On a sunny day, with the pipe snugly laid in the marsh, Santa Clara Ave. was like a peaceful valley; but after notice was served that the streets in the vicinity were to be graded, it proved to be a veritable "slough of despond." The first notice was the intention to grade Santa Clara Ave. from Missouri to Carolina St., and the intersecting streets. This covered four blocks, or about 1,200 ft. of the 24-in. main, and it became necessary to uncover and raise it before the filling was begun.

Before proceeding with a description of the raising of this large pipe, I want to lay stress upon the fact that this pipe was the main artery of the city's gas supply which was constantly under pressure, and through which over three-fourths of all the gas supplied by the San Francisco Gas Light Co. was drawn. This was previous to the building of the new works at North Beach, and there was no substitute of any kind for it.

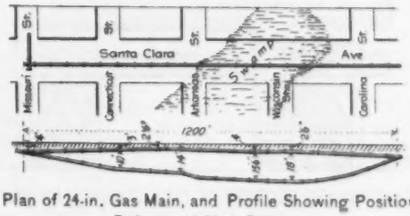
On Dec. 16, 1890, work was commenced raising the pipe on Santa Clara Ave., between Mission and Carolina Sts. It was necessary to raise the main without cutting or breaking it, and its success depended in a great measure on its flexibility due to lead joints. Had the joints been of cement, as they are almost uniformly made in Eastern cities, the rigidity of pipes and joints would, without doubt, have caused a break, or, perhaps, many serious breaks; but with about 100 lead joints, 4½ ins. deep and ½ in. thick, it became possible to raise the main without a fracture.

The first section to be raised weighed about 260,000 lbs., and the method employed in raising it was as follows: The pipe was first uncovered, the trench extending to the bottom of the main, and at intervals of 12 ft. of its entire length house mover's frames were placed on each side, one above another, to the desired height. A 12×12-in. timber was placed across these tiers of frames, passing over the pipe just behind each joint. Heavy chains were passed around the pipe, back of each heel, and what is known as a 2-in. "holder screw" was hooked to each chain and passed through a hole in the timber above. On the upper surface of the timber was an iron washer, and on this rested the large nut on the thread of the holder screw.

After taking up the slack on each chain, a man was detailed with a wrench to each screw, and at a signal from the foreman each man took one turn of the wrench, and the pipe was gradually raised. As the main was raised from the marsh, a gang of men was employed in blocking under it, to prevent its falling in case of the accidental breaking of any part of the lifting machinery, until finally, when it was raised to the desired height, or about 3 ft. below the official grade of the street, the pipe was temporarily supported by house frames. 780 of these frames, each 2½ ft. high, were used in raising and supporting the pipe.

The next step was the permanent support of the pi previous to the filling of the street. This was done by constructing a series of wooden trestles, 5 ft. wide at the top and 12 ft. wide at the bottom. They were made of 8×8-in. uprights, with a sill underneath, and a cap at the top of the same dimensions, and braced diagonally by pieces 2×10-in. on each side. After the completion of the trestles, all the other supports, including the house frames used for raising, were removed, and apparently nothing remained to be done but to fill in the street with solid filling. The pipe had been raised without accident of any kind; all the joints had been re-calked where they had drawn, and the permanent supports were amply strong.

The filling of the street was commenced immediately after the pipe was raised. This was done by taking the rock from the hills east and south of the fill, and transporting it in cars to the dump. This work was done by a contractor for the city. As fast as the street was filled to grade, a gang of men kept the 24-in. pipe uncovered, and all went well until the fill reached the corner of Santa Clara Ave. and Arkansas St., when, on Saturday, April 11, 1891, at 11 o'clock p. m., the northerly side of the street began to slide toward the north, carrying the pipe and its supports with it. The



Plan of 24-in. Gas Main, and Profile Showing Position Before and After Raising.

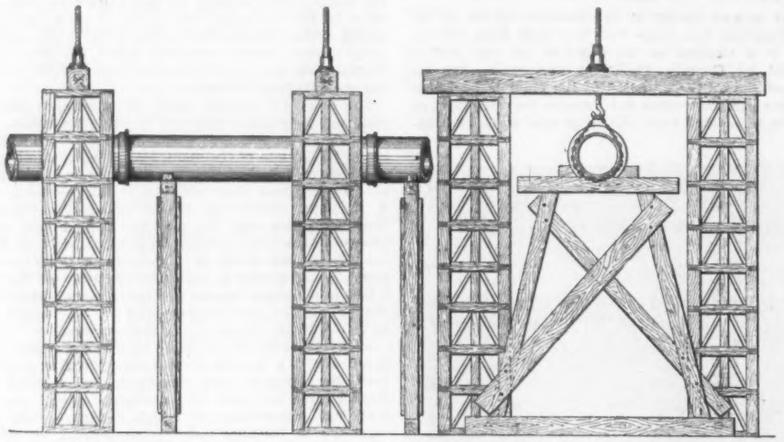
main settled 4 ft., and slid to the north 3 ft., and the wooden trestles were canted over in the direction of the slide.

A gang of men was immediately put to work shoveling the rock and earth away from the trestles to remove the pressure against them, and to distribute the material under the pipe. The following day a number of teams were employed to cart the material from the face of the dump, and to spread it along the line of the pipe, under and on each side of it. The object in thus carting the rock was to distribute evenly the load on the marsh, and gradually raise the whole street to the level of the pipe, instead of keeping up to the street grade, and presenting a steep face at the dump. Cart-

* A paper read before the Technical Society of the Pacific Coast, March 3, 1893.

ing rock was continued until we had filled in solid under the pipe, and had built a cartway about 9 ft. wide on each side of the pipe, level with the bottom of it. This required the handling of 5,000 loads of stone. As the stone was hauled ahead and loaded on the marsh, the street continued to settle, carrying the pipe with it.

Four days after this first trouble, the crossing of Arkansas St. commenced to settle very rapidly, and in 15 minutes the street had gone down 4 ft. The large body of rock settling in the mud, raised the surface of the marsh, at a point about 100 ft. north of the street, about 5 ft. high, and opened a crevice about 1 ft. wide. This was a natural consequence of the displacement of mud by the heavy fill of stone, but why over half of the filled street should slide bodily toward the north at the same time, and where and when it would bring up, were

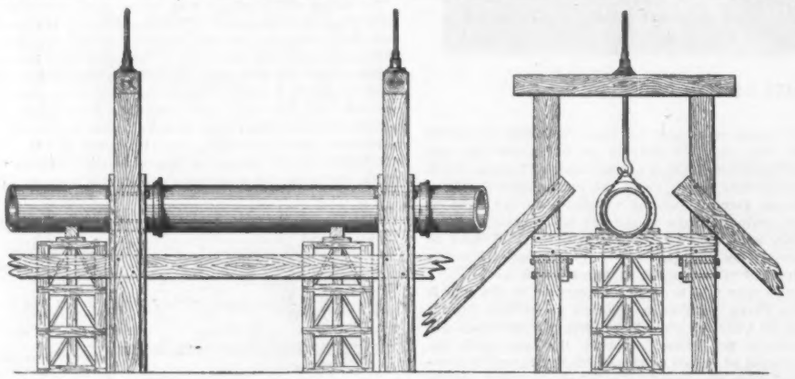


ELEVATION AND SECTION OF FRAMING USED IN RAISING AND SUPPORTING FIRST SECTION OF PIPE.

perplexing questions. To ascertain the exact nature of the underlying strata of the marsh, and solve at least one of these problems, we caused soundings to be made in lines 96 ft. long, extending from south to north, at right angles to the pipe, by driving a ½-in. iron bar into the ground. The crust of the marsh was found to be fairly firm to a depth of 3 ft., consisting of a sort of marl.

At the northerly side of the street, after passing through the crust, the bar sank into 19 ft. of soft mud and then reached hard bottom. At the middle of the street the bar went down through 7 ft. of the same mud, while on the south side there were but 2 ft. 6 ins. of the mud under the crust of the marsh. The stratum underlying this mud was an extremely hard clay.

These soundings explained to my satisfaction the cause of the body of rock sliding toward the north. The



ELEVATION AND SECTION OF PILE STRUCTURE USED IN RAISING AND SUPPORTING SECOND SECTION.

surface of the marsh was nearly level, but the thick body of soft alluvial mud was resting on a subterranean side hill of hard clay, sloping toward the north with a trend of 14%; and as the rock fill sank into the mud it slid, mud and all, down the slope of the hard bottom.

The soundings also explained the sudden and spasmodic settling of the fill. The 3 ft. of firm crust over the marsh offered a resistance to the load of rock piled upon it, until the load was sufficient to overcome the resistance, when the crust broke, letting the entire fill settle from 4 to 5 ft. at a time.

After the second settling of the pipe it was necessary to resort again to the house frames for raising it, as the wooden trestles had sunk into the marsh and were almost useless. After raising the pipe with screws to the proper height, jack-screws were used for forcing it laterally toward the south, back into its proper line. By continuous wedging under the pipe, using in all about ten cartloads of wooden wedges, we managed to keep the pipe in its place until May 1, when another settlement occurred opening long fissures in the fill and raising the surface of the marsh to the north about 9 ft., and at the same time opening several long cracks nearly 2 ft. wide. This was the most trying period of the whole undertaking, and as a safeguard I laid a line of 20-in. pipe on the surface of the marsh, south of Santa Clara Ave., and cut the 24-in. pipe between Missouri and Arkansas Sts. and at Carolina St., and put in 24 × 20-in. T's.

This was done so that in the event of the destruction of the 24-in. main we could, by making short connections with the 20-in. main, provide a way to deliver gas to the city temporarily. Fortunately, however, this new line was never used, but its presence was a source of relief.

The last serious settlement occurred on May 16, 1891, when 12 × 12-in. timbers, 30 ft. long, were placed under each length of pipe, back of the joints, and the end of the timber toward the north was blocked up about 2 ft. higher than the south end. With this precaution we were enabled to keep the pipe wedged up in place, although it was a constant source of worry and annoyance, until the rockfill had found a bottom on the hard clay and the street was brought to grade. At the crossing of Arkansas St., which was the worst part of the marsh, the main was raised at the beginning 16 ft., and the sum of all the settlement at that point was 14 ft.; that is, the entire fill settled into the marsh that distance, so that it was necessary to raise the pipe in all 30 ft. to maintain it at the 16-ft. level.

The contractor continued filling in until July 31, 1891, and the average amount of material dumped each day, from May 1 to July 31, was 23 trainloads of nine cars each, or about 207 cu. yds. per day. As the contractor completed filling the street to grade, the pipe was kept uncovered, and a 12 × 12-in. timber was placed across each length of pipe, resting on blocking and wedges, chains were passed around the pipe and holder screws were used for sustaining it. For months it was necessary to keep careful watch of the pipe, and men patrolled its entire length day and night, driving wedges and taking up the slack on the chains wherever needed. In fact, during all this time Santa Clara Ave. became one of the company's telephone stations, and for awhile was the one most frequently used. Finally, in November, 1891, the street had stopped settling, the timbers and screws were removed, and after carefully tamping the earth under the pipe, the trench was filled.

Early in October, 1891, notice was received of the intention to grade Santa Clara Ave. west from Carolina St.; and as the 24-in. main extended west as far as De Haro St. (304 ft.), it was necessary to raise it out of the marsh. At De Haro St. the pipe turns at a right angle, and extends to Center St. (510 ft.), and it was necessary to raise the entire 814 ft. an average of about 8 ft. in height.

A pile structure was built to raise and sustain the pipe. Sixteen-inch piles, 50 ft. long, were driven through the marsh into the hard clay bottom. These piles were spaced 12 ft. apart, and were 5 ft. from the pipe on each side. Ten feet outside of each standard pile a brace pile was driven and sawed off 2 ft. from the ground. On each side of the standard piles, extending down to the brace piles, were diagonal braces 4 × 12-in. Caps 12 × 12 ins. were placed over the main, resting on the top of the standard piles, and a screw passed through a hole in the middle of each cap. The pipe was raised as before described.

When the pipe reached the proper grade, waling pieces 4 × 12 ins. were bolted on the inside face of the standard piles, and across these were placed two planks, 4 × 12 ins., on edge, resting on the waling pieces and bolted through the piles. The pipe rested on these 4 × 12-in. cross-pieces, and was prevented from rolling by pieces of 4 × 4-in.; the entire wooden structure was securely bolted together. The standard piles were for raising and permanently supporting the pipe, and the brace piles and the diagonal braces were to withstand any side thrust caused by sliding of the marsh.

One of the difficult features of this piece of work was the bracing of the right angle in the main, at the corner of Santa Clara Ave. and De Haro St. This was accomplished by driving ten piles around the T at the corner, and by a system of diagonal braces. To prevent the pipe from drawing apart, iron bands were bolted around it at the corner, and these bands were connected on each side by rods with turn-buckles.

After the pipe was raised and supported, the 12 × 12-in. caps were removed, and the tops of the standard piles were sawed off below the grade of the street. As the street was filled, the pile structure stood the strain of the street settling, but there was little or no lateral thrust as the clay under the marsh was nearly level at this point, and the fill did not slide.

This piece of work was not subject to any of the unfavorable conditions that so seriously affected the first part of the work. In fact, the method employed to raise the first section would have been successful in raising the second section, but it is doubtful if any wooden structure would have withstood successfully the various forces exerted to overthrow it at the crossing of Santa Clara Ave. and Arkansas St.

The test of magazine guns commenced at Springfield, Mass., on March 30, before the U. S. Small Arms Board. Over 30 guns have been submitted by inventors, mostly Americans.

The British Post Office Telegraph is far from being a financial success, after twenty-three years' trial. For the financial year ending March 31, 1892, the system was worked at a loss of $1,945,835, as compared with a loss of $1,155,165 in the year ending in March, 1891. The aggregate loss, since the Treasury acquired control, in 1870, and up to March 31, 1892, was $22,318,430 This loss includes the interest on the 2¾% consols issued to provide for the purchase of lines, an investment which now amounts to $54,343,320 and involves an interest charge of $1,494,440. The actual excess of working expenses over current revenue, in 1891-92, was $451,415; and this would have been $629,360, had not credit been given for free work done for the public departments. It should be said, however, that the government forwards 12-word messages for 6d, or 12 cts., to any part of the United Kingdom; while in 1870 the private companies charged 4s., or $1 for 20-word messages from London to Edinburgh.

The total length of underground conduits for electric wires laid in Minneapolis, Minn., to Jan. 1, 1893, according to the last annual report of Mr. Andrew Rinker, City Engineer, is about 167,000 ft., or over 31 miles. There are four systems of conduits. The Northwestern Telephone Exchange Co. uses a rectangular vitrified clay pipe conduit, with two compartments, into each of which six cables are drawn. This company has 27,605 ft. of conduit. The Minneapolis Electric Subway Co. built a Dorsett conduit, made of an asphalt composition. This conduit, the total length of which is 48,384 ft., is used by the Brush Electric Light Co., which in making extensions of its system has used iron pipe. The Dorsett conduit (Eng. News, Sept. 11, 1886) also contains the wires of the city, rental free. This conduit was built for rental to the various electrical companies of the city. The Edison Light & Power Co. uses a pipe, containing three wires, from every joint of

which underground service connections can be run. The Telephone and Brush companies distribute their service connections from a pole in the center of each block. The Edison Co. has 49,928 ft. of conduit, and the Western Union Co., which owns the fourth system, has 13,421 ft. The character of the latter conduit is not stated. Through the business portion of the city the street railway company has about 14,000 ft. of conduit containing its feed wires.

A case of good preservation of timber is reported from Providence, R. I. During the building of a bridge over the Providence River near Crawford St. recently it became necessary to remove some of the timber put into the bridging around the open river spaces in 1875. The hard pine timber was found to be remarkably well preserved for its 18 years' service in the moist position it occupies over the river. In fact, it hardly showed any rot. Where the sidewalk covering was tar concrete, the surface water did not find its way to the timber, and the wood is now almost as good as new. The pile caps and stringers were covered with tar paper when laid, and it is no doubt due to this precaution, which originated with the city engineer's department years ago, that the timber is so well preserved. The foulness of the river had prevented the worms from eating the piles.

The tires of French market wagons are from 3 ins. to 10 ins. in width, usually from 4 ins. to 6 ins. In addition to this the rear axle is the longest, and the hind wheels run on a line outside the track of the front wheels. As a consequence, the tractive force required is less for the load carried, and the wagon itself is a roadmaker instead of a road destroyer. The Ontario Department of Agriculture has recently sent out a special bulletin on the making and maintenance of highways, and, among other things, says that for wagons without springs the tire should not be less than 2½ ins. wide for a load of 500 to 1,000 lbs. on each wheel. For loads of 2,000 to 3,000 lbs. on each wheel the tire should not be less than 6 ins. wide.

PERSONALS.

Mr. D. M. Starr has been elected City Surveyor of Litchfield, Ill.

Mr. H. M. McIntosh has been elected City Engineer of Burlington, Vt.

Mr. B. F. Yoakum has been appointed General Manager of the Gulf, Colorado & Santa Fe R. R., vice Mr. C. O. Wheeler, resigned.

Dr. Charles F. Roberts has been appointed Sanitary Superintendent of New York, vice Dr. Cyrus Edson, who has been appointed Health Commissioner.

Mr. W. F. Williams has resigned his position in the Cumberland Lands Co., Ltd., of Dover, Tenn., and will open an office as civil engineer at New Bedford, Mass.

Mr. L. C. Fritch, Engineer of Maintenance of Way of the Ohio & Mississippi Ry., has been appointed Chief Engineer, vice Mr. C. C. Chandler, who resigned some time ago.

Mr. R. A. Bryan, who has been City Civil Engineer of Portsmouth, O., for the last 13 years, has resigned, the resignation to take effect May 1, 1893. His successor has not yet been appointed.

Mr. Wallace C. Johnson, of Niagara Falls, N. Y., has formed a partnership with Mr. Albert H. Porter, formerly resident engineer of the water power tunnel, under the firm name of Johnson & Porter.

Mr. J. K. Kendrick, General Manager of the Old Colony R. R., has been appointed Third Vice-President of the New York, New Haven & Hartford R. R., which has now acquired the Old Colony R. R., with offices at Boston, Mass.

Mr. Geo. Crocker has resigned his position as Division Engineer of the Chicago Extension of the Wabash R. R., to accept the position of Principal Assistant Engineer of the Ohio Southern R. R., with headquarters at Springfield, O.

Mr. Thomas T. Brerton, of the engineering corps of the Pennsylvania R. R., has been made engineer of the Cumberland Valley R. R., vice Major Chauncey Ives, who has accepted a position with the West Virginia Central R. R.

Mr. George Hill, Mem. Am. Soc. M. E., and Assoc. Mem. Am. Inst. Elec. Engrs., for several years Chief Engineer and General Manager for Carrere & Hastings, architects, has opened an office as consulting engineer at 44 Broadway, New York

Mr. James Dredge, editor of London "Engineering," and member of the British Commission to the World's Columbian Exposition, is to be given a complimentary dinner at the Engineers' Club, in New York, on April 15, by resolution of the Board of Management of the club.

Mr. Lewis F. Root, of Westfield, Mass., County Commissioner of Hampden County, died March 31, at the age of 65. He was one of the engineers on the construction of the Union Pacific Ry., and was for several years Chief Engineer of the New Haven & Northampton R. R.

Mr. A. Fteley, Chief Engineer of the New Croton Aqueduct, lectured this week to the students of the Engineering School of the University of the City of New York. An interesting description was given of some of the difficulties encountered during the construction of the aqueduct.

Mr. Schuyler Hazzard, Engineer of Maintenance of Way on the Cleveland Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., has been made Assistant Chief Engineer, with office at Indianapolis, and will be succeeded by Mr. W. M. Duane, of the Indianapolis Division, which will be added to the charge of Mr. F. Woodbridge, of the Sandusky Division.

Mr. Wm. Hazelton, 3d, who has been connected with the Short Electric Ry. Co. for some years, has been appointed Assistant General Manager of the Brush Electric Co., Cleveland, O. Mr. L. W. Bradley, for a number of years Purchasing Agent of the company, has resigned, and Mr. H. J. Wendorff, who has been for a long time at the head of the storerooms, has been appointed in his place.

Sir George Findlay, for many years General Manager of the London & Northwestern Ry., of England, died March 26, at the age of 63. He was born in 1829, and began his railway career in 1845 under Mr. Brassey, then contractor for the Trent Valley Ry. Later he became manager of the Shrewsbury & Hereford line, which was acquired by the London & Northwestern Ry. in 1862, of which road he became Chief Goods Manager, and in 1874 Traffic Manager. He was knighted in 1892, as a recognition of the work he had done in the development of English railways. He was the author of an interesting work, "The Working and Management of an English Railway," dealing, mainly in a popular manner, with the road with which he had so long been connected.

Mr. Deodatus Hilin Neale, who died in Brooklyn, N. Y., April 5, was born Sept. 5, 1849, in England, and was educated as a mechanical engineer. He was at one time Chief Draftsman of the London & Northwestern Ry., and afterward Assistant Locomotive Superintendent of the Cape Government Railways, in Cape Colony. In 1883 he came to the United States to report for "Engineering," London, on the exhibition of railway appliances at Chicago, and in November of that year he joined the editorial staff of the "Railroad Gazette." In November, 1888, he accepted an appointment as Mechanical Engineer to the Railway Commissioners of New South Wales, and went to Sydney, where he remained until the summer of 1892. He was largely instrumental in introducing American locomotives, Pullman cars and the Westinghouse air brake on the colonial railways. In November, 1892, he returned to New York, and resumed his position on the "Railroad Gazette," as associate editor, and occupied that place at the time of his death. He was an Associate Member of the Institution of Civil Engineers (England), and an Associate Member of the Master Car Builders' Association. He was an able writer on technical matters, and had a very thorough perception of the principles of railway operation. The cause of his death was cerebral meningitis.

NEW PUBLICATIONS.

TREATMENT OF THE SOULINA MOUTH OF THE DANUBE, FROM 1857 TO 1891. By M. Voisin Bey. Annales des Ponts et Chaussees. January, 1893. Paris. Ch. Dunod, Editor, No. 46 Quai des Augustins.

While this matter is contained in a monthly journal publishing the memoirs, etc., of the corps referred to, the work done at the mouth of the Danube is so often referred to in connection with river treatment, that any detailed information is especially welcome. In this number M. Voisin Bey devotes 262 octavo pages to a sketch of the progress of the work during the period 1857-1891, and accompanies his remarks by plans of works, soundings at various periods, etc. It is, in fact, the summary of the three very full memoirs published in 1865, 1873 and 1887, by the European Commission of the Danube, of which Sir Charles Hartley was the Chief Engineer from 1856 to 1872, and to which he is still consulting engineer. The chief engineer since 1872 is M. Kuhl. Our chief purpose is to put this work of M. Voisin upon record for the benefit of our interested readers. Space at our disposal forbids even an attempt at an abstract of what is in itself a digest of a description of an important public work of nearly 40 years' duration.

TRADE PUBLICATIONS.

GARBAGE DISPOSAL.—P. Hogan, New York. 8vo; pp. 8.

This pamphlet is descriptive of the "odorless" cremating process, in which the garbage is cremated in a closed revolving chamber, with provision for the recovery of ammonia, etc.

SOCIETY PROCEEDINGS.

MONTANA SOCIETY OF CIVIL ENGINEERS.—The regular monthly meeting was held on Saturday, April 8, at the office of Sizer & Keeri, in the Atlas Block. The paper for the evening was by A. E. Cumming, on "The West Gallatin Irrigating Canal."

G. O. Foss, Secy.

ASSOCIATION OF ENGINEERS OF VIRGINIA.—The next informal meeting will be held at the Association's rooms in Roanoke, April 26, 1893, postponed from April 19. The subject for discussion will be "Aluminum," the discussion to be opened by Mr. J. C. Rawn. The alternative subject will be the "Proper Method of Disposing of Sewage in Isolated Buildings, Where no Drainage System is Available," the discussion to be opened by Mr. R. P. E. Sanderson

L. J. Carmalt, Secy.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.—The regular monthly meeting was held April 3, President Wilson in the chair, 11 members and 23 visitors present. Mr. Estabrook read a paper on "The Isthmus Canals and Their Relation to a Deep Waterway Between the Great Lakes and the Atlantic Seaboard at New York." He gave the history and description, fully illustrated by maps, of the Suez, Panama, Nicaragua and Erie canals, and presented tables of statistics. He closed with the expression of some broad views on the canal question. C. L. Annan, Secy.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on April 5, a letter was read from Mr. Schmidt, secretary of the general committee of Associated Engineering Societies, asking that lists of the important civil, mechanical, mining, metallurgical, electrical, military, marine and naval engineering works and industries of St. Louis and its vicinity, be made out in order to aid visitors to the World's Columbian Exposition in making visits to see the work which they might be interested in. Professor Johnson moved that a committee of five, with the President as chairman, be appointed to act as an entertainment committee, and the motion was carried.

Prof. J. H. Kinealy read a paper on "Standardizing Indicators," giving full details of indicators and their errors, and the methods of correcting these errors.

Arthur Thacher, Secy.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF PHILADELPHIA.
April 15. 1122 Girard St. Secy., L. F. Rondinella.
COLUMBIAN ENGINEERING SOCIETY.
April 18. Secy., F. W. Hart, Washington, D. C.
WESTERN RAILWAY CLUB.
April 18. Secy., C. F. Street, Rookery Building, Chicago.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
April 18. Secy., R. H. Clark, Pittsburg.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
April 19. Secy., F. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS.
April 19. Secy., Arthur Thacher, Odd Fellows' Building.
BOSTON SOCIETY OF CIVIL ENGINEERS.
April 19. Secy., S. E. Tinkham, 36 Broomfield St.
NEW YORK RAILROAD CLUB.
April 20. "Rules of Interchange of Freight Cars." Secy., H. G. Prout, 73 Broadway, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
April 20. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
April 20. Secy., C. F. Franson, Portland Block.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 20. Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
April 21. 201 Washington Building.
DENVER SOCIETY OF CIVIL ENGINEERS.
April 25. Secy., F. E. King, Jacobson Block.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
April 26, Informal meeting. Secy., L. V. Carmalt, Roanoke, Va.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
April 28. Secy., C. H. McLeod, Montreal, P. Q.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
May 1. Secy., C. L. Annan, City Engineer's Office.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
May 2. Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
May 3. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS.
May 4. Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
May 5. Secy., E. K. Smoot, 305 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
May 5. Secy., O. Von Geldern, 719 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
May 6. Secy., P. Valentine, At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
WISCONSIN POLYTECHNIC SOCIETY.
May 8. Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
May 8. Secy., Waterman Stone, Baird Building.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
May 9. S. W. Spear, E. Buffalo, N. Y., Iron Works.
NORTHWESTERN SOCIETY OF ENGINEERS.
May 9. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
NORTHWEST RAILROAD CLUB.
May 9 Ryan Hotel, St. Paul. Secy., W. D. Crosman.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
May 9. Secy., F. C. Osborn, Case Library Bldg.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
May 10. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
May 10. Secy, F. M. Curtis, O. C. R. R., Boston.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
May 11. Secy., F. W. Mowbray, Norton Building
ENGINEERING ASSOCIATION OF THE SOUTH.
May 11. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
May 12. Secy., D. W. Mosher, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
May 13. Secy., F. D. Jones, Helena.

ENGINEERING NEWS

AND

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The standard solid floor for bridges used on the Adirondack & St. Lawrence R. R., described and illustrated elsewhere in this issue, is worthy of note as one of the most prominent applications of solid bridge floors to long-span bridges so far made in this country. The advantages to be gained are so many in safety, permanence and smooth-riding track that we feel like insisting in season and out of season on the importance of this reform in the construction of bridge floors The growing demand for accelerated speed in passenger trains, and the ever-increasing weight of rolling stock of all classes, necessitate an advance in the rigidity and strength of bridge floors. These conditions we believe to be most fully met by solid floors, especially for bridges of short span. They possess the fundamental advantage of concentrating a certain amount of extra dead weight where it can the most effectually absorb the shocks of passing trains. The impact is dissipated and absorbed by the floor and ballast, and carried to the abutments, something in the nature of a dead load. Thus the structure is not easily set in motion, and there is little metallic deterioration or hammering of abutments. Experience has pretty completely refuted the objections of danger from corrosion and inaccessibility for repairs first brought against the system. The most valid objection which can be urged is that of increased first cost; for the floor is more expensive than a wood floor, and it is idle to deny or blink at the fact. At the same time there is a considerable saving in abutment masonry in first construction, by doing away with back walls, and a very large saving in the maintenance of the whole substructure. The repairing and rebuilding of abutments every eight or ten years, which have been hammered to pieces by deck plate bridges, is an expensive item in maintenance, and one that increases rapidly with the growth of traffic, as every railway engineer knows. This item alone will more than repay the outlay required to build solid floor bridges. Moreover, it occurs most frequently with short-span bridges, to which the solid floor is admittedly best adapted.

Aside from the inherent advantages of solid floors for all bridges, irrespective of conditions, there are special advantages to be gained from its use in certain situations, as, for example, where the depth of the floor is restricted. An interesting case of this character was described by Mr. George S. Morison, M. Am. Soc. C. E., in discussing a recent paper presented to the society. The case mentioned was the bridge across the Willamette River, at Portland, Ore., consisting of a 300-ft. fixed span, and a 340-ft. swing span. The floor was constructed of trough sections of basic steel, for the purpose of getting the track as low as possible, and also to make the whole bottom of the bridge a horizontal plate girder, which should be able to withstand lateral shocks from floating timber, etc. Within a year after its completion the floor received its first baptism by fire, when an unusually heavy flood raised the water nearly to the bottom chords of the bridge. The swing span remained closed during the flood. The turntable was submerged, and the pile fender above the pivot pier washed away. The current was at least eight miles an hour, and carried a great deal of drift, much of it very large trees, the roots and branches of which were sheared off by the bridge. Indeed, so many trees struck the chord that after the flood slivers and splinters could be seen under every rivet head along nearly its whole length. Under the conditions Mr. Morison states that "any ordinary truss bridge would have been destroyed, but the strength of the horizontal plate girder which formed the floor of this bridge saved it, and it was entirely unhurt." Of course, cases of this kind are comparatively rare, but when they do occur they offer good opportunities for the use of solid floors to advantage, and these are not the only cases in which increased lateral stiffness would be advantageous to the structure.

Notwithstanding the public demand for a flat grooved rail on street car lines in paved streets, a majority of the managers of street railways avow their preference for a T-rail wherever the authorities will permit it. Its advantages over the flat rail are that dirt does not so readily lodge on it, and hence the resistance to the movement of the car and also the resistance to the passage of electric current from the wheel to the rail is much less. What is of still more practical importance, the form of the rail is such that wagons cannot follow it. The objection to wagon travel on the rails is not only the additional wear, but the obstruction of the movement of the cars. All these are legitimate advantages of the T-rail; and if they can be gained without infringing on the public rights, there is no justice in compelling street railway companies to adopt other sections of rail. It may be argued that the rail section should be such as to permit wagons to run upon it; but if the rail is placed on a level with the pavement, and that is brought up flush against it on the outside, so that the rail presents no obstruction to the street traffic, it is not apparent that a street railway company is under any obligation to adopt a type of rail which is not the best for its own use in order that wagons may be able to run upon it. The permanent success of the T-rail depends on whether it can be so made and laid as to leave the pavement practically unobstructed. To do this it is necessary to use a deep rail which will permit the paving blocks to be laid on its base and to fit closely against its web. In some western cities we are informed that vitrified brick are being used for paving against the rail, as they permit a tighter joint to be made than when stone blocks are used. With electric or cable traction there is no necessity for using cobble-stone paving between the rails, and the pavement of the whole street can be made of one material. A method of paving around T-rails with asphalt was illustrated in our issue of Feb. 23, 1893.

In considering the relative merits of the flat-topped rail and the T-rail from the city's standpoint it should be remembered that with a rail which wagon wheels will readily follow, traffic will largely keep on the line of the rails; but most horse vehicles are of wider gage than the street cars; hence while the wheels on one side follow the rail, the wheels on the other side run on the pavement, and the great concentration of traffic on a single line soon causes a deep rut to wear in the stone blocks. With a T-rail properly laid, on the other hand, there is nothing to guide wagons in one line, the wear is evenly distributed over the pavement, and its life will be much longer.

ENGLISH AND AMERICAN TRAIN LOADS.

A few months ago, during one of the discussions on English and American railways which occur periodically in the English technical papers, there was an animated discussion between "The Engineer," of London, and one of its correspondents as to the train loads hauled by English and American locomotives. This correspondent instanced the heavy loads hauled in America, and urged the use of more powerful engines in England to haul express trains which are now run practically in sections, although nominally as separate trains, at close intervals. The "Engineer," as usual, denied any superiority for America, although it constantly shows an absolute lack of familiarity with and information in regard to American railways, and then proceeded to make the startling assertion that the lightest English express trains were heavier than the heaviest American express trains. This arose partly from its correspondent making a special feature of the Empire State express, on the New York Central & Hudson River R. R., which is one of the lightest of American express trains, and makes the longest high-speed run in the world, running from New York to Buffalo, 440 miles, with four intermediate stops, in 8 hours 40 minutes, or at the average speed of about 51 miles per hour for the 440 miles, without deducting time for stops. Even this is to be beaten, however, in length of run, as the same road intends to put on a train to make the run of 980 miles from New York to Chicago (over the Lake Shore & Michigan Southern Ry. from Buffalo) in 19 hours, or at the average speed of 51.4 miles per hour for the entire run, which means very much higher rates of speed between stops. The Empire State express weighs about 140 tons, and the new train will probably be somewhat heavier, having sleeping cars, instead of the light day cars of the former train.

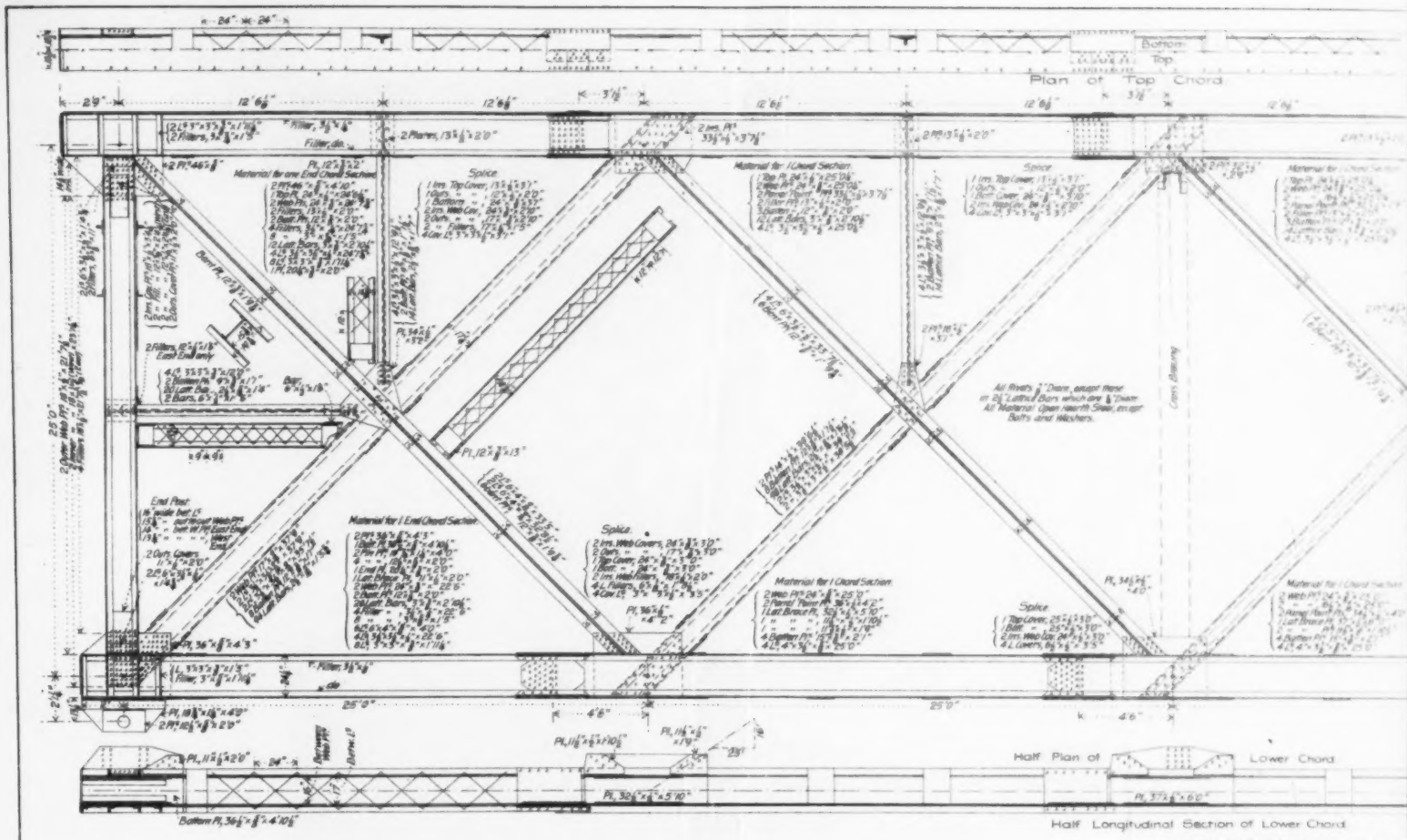
The above, however, are not examples of regular heavy express trains of American railways. We discussed the question briefly in our issue of Jan. 12, and showed the fallacy of the argument of "The Engineer," which, based upon the performance of the Empire State express, was as follows:

It will, perhaps, come as a surprise to him to learn that the work done on the Great Northern is very much in excess of that on the American road. The engine and tenders working the latter weigh 92 tons, and haul a train weighing 143 tons. But the Great Northern engines and tenders weigh 85 tons, and haul in summer trains weighing 240 tons; that it to say, 16 coaches weighing, without passengers or luggage, 15 tons each; and in winter the load is 12 coaches or 180 tons. The lightest express trains on the Great Northern weigh almost as much as the heaviest on the American road, and the speeds are certainly not inferior on the former.

The position taken by the correspondent of the "Engineer," signing himself W. M. A., is best shown by the following abstract of a letter by him, published in that paper Dec. 2, 1892:

An average mile of railway in England has cost a little under $250,000. I believe that $500,000 per mile is a fair estimate for adding two additional "tracks"—the American phrase is really the only unambiguous one—with their necessary complement of new stations, sidings, signals, etc., to an existing main line. The rent of one mile of this new line would then be, apart altogether from maintenance charges, $25,000 per annum, say $500 per week for both tracks, $250 per week (that is) for one track. Roughly, this makes $35 per day, or—20 minutes being 1-72 of a day—50 cts. per 20 minutes. Even assuming that my price is too high, that a mile of first class main line in a thickly populated district—we are not discussing agricultural branches—can be provided and fully equipped for half the money, or $250,000; assuming, further, than an express only occupies the line for 10 minutes instead of 20, still the rent of line for the time of its passage is 25 cts., and it is bad economy to spend 25 cts. to save two cents' worth of coal.

You press me with questions whether an increase in the number of trains does not diminish the cost of rent per train. Of course it does; but the fact is quite irrelevant to my argument. What I urge is this: the number of trains increases gradually; there comes a point where the trains overcrowd the original two lines, not, indeed, all day long, but at certain hours. Then the two lines have to be increased to four, as happened years ago on the London & Northwestern, and is happening now on the Great Western and the Midland. But though, thereby, the capital cost of the main line per mile is doubled, no new traffic comes upon it in consequence. The management have got an easier task in working the traffic, no doubt, but the shareholders'


Plan of Top Chord
Half Plan of Lower Chord
Half Longitudinal Section of Lower Chord
Material for one End Chord Section
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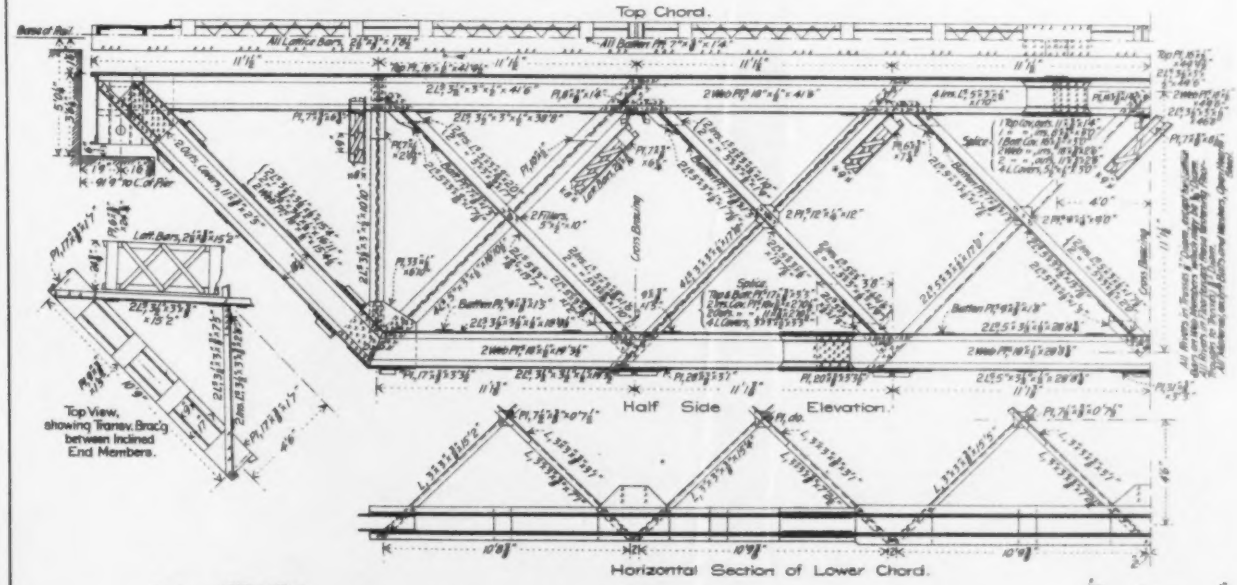
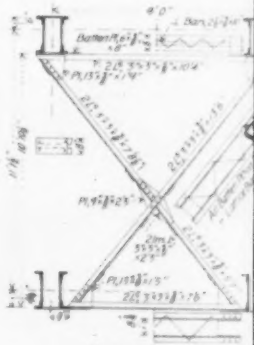
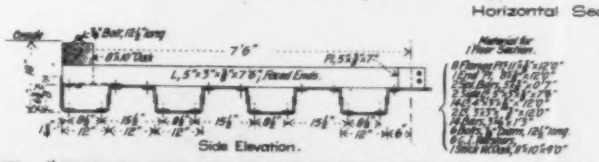
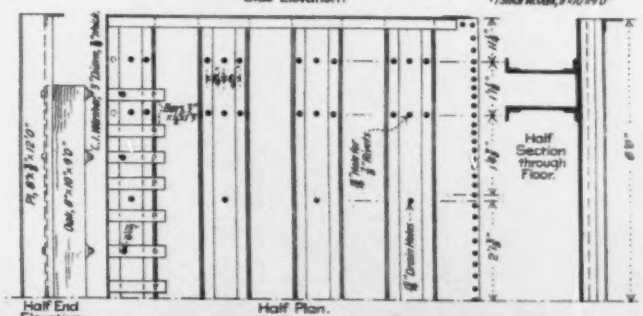
HALF ELEVATION AND SE


Top Chord.
Half Side Elevation.
Horizontal Section of Lower Chord.
Top View, showing Transv. Brac'g between Inclined End Members.

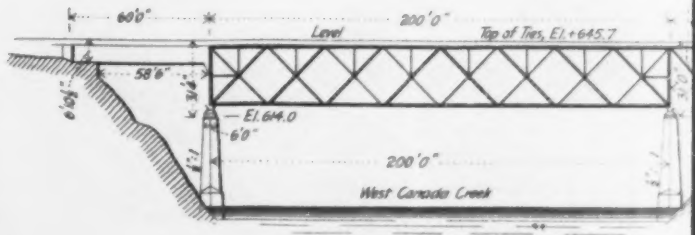




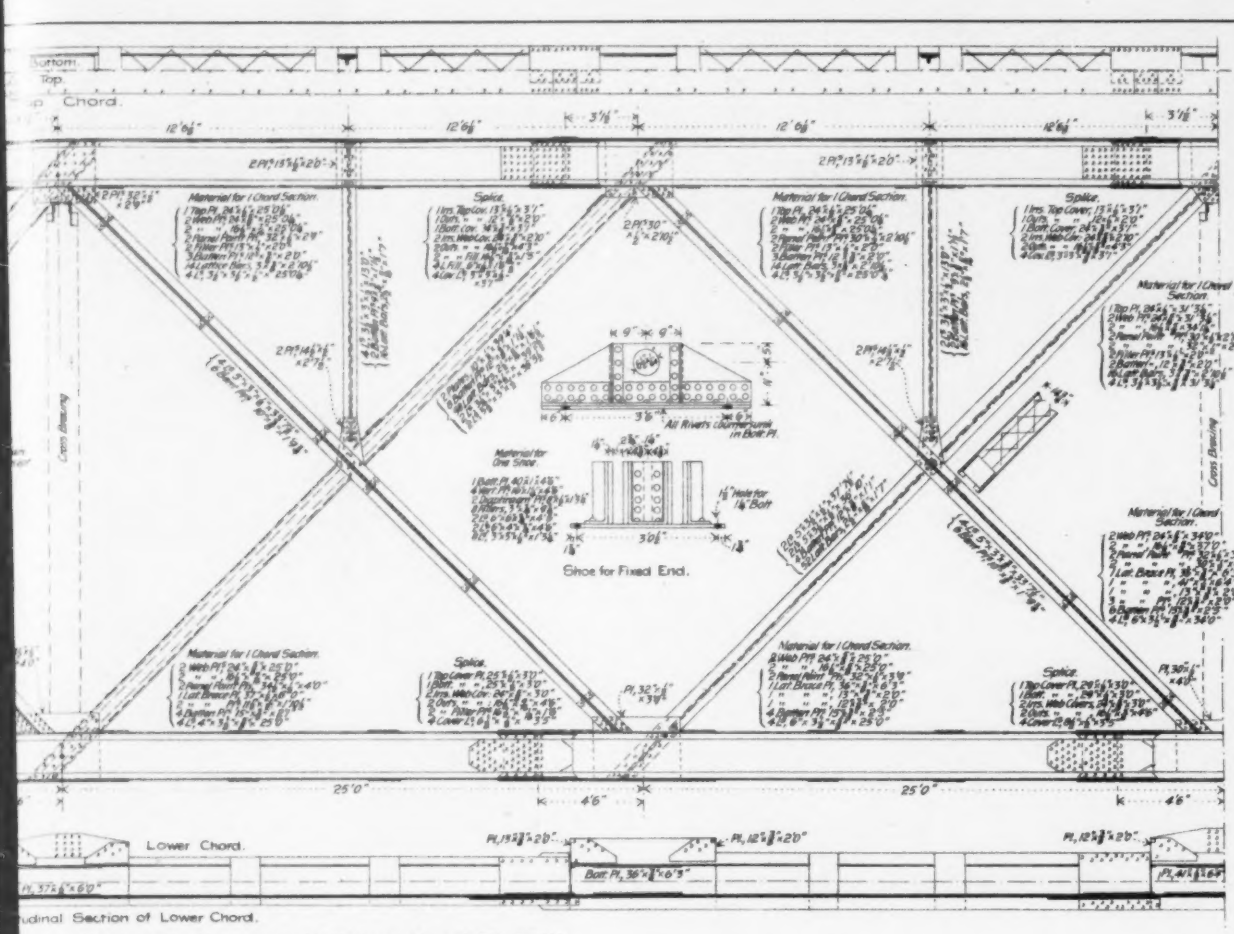
DETAILS OF 90-FT. SPAN.



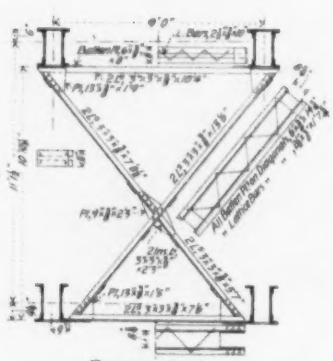
DETAILS OF FLOOR SYSTEM FOR 60-FT. AND 90-FT. SPANS.

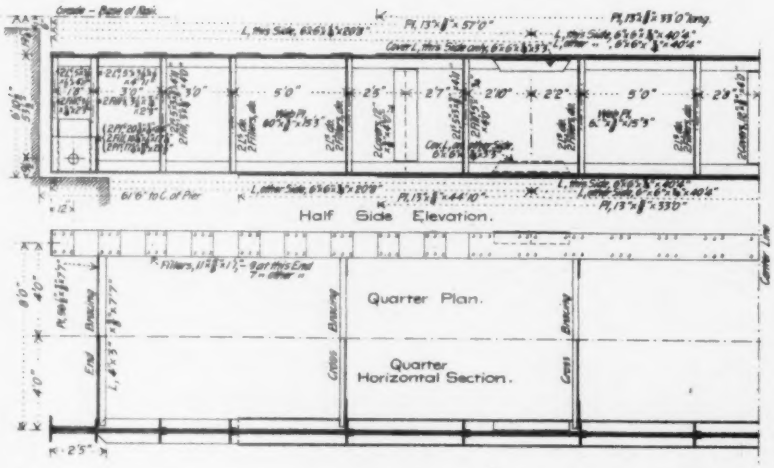


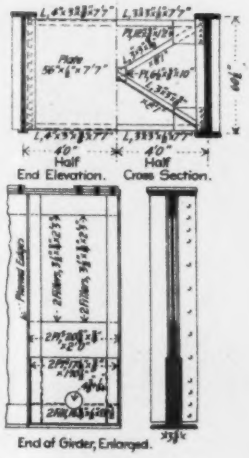
GENERAL ELEVATION

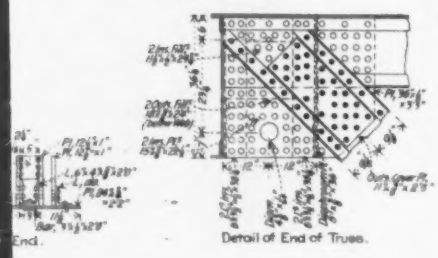


HALF ELEVATION AND SECTIONS OF 200-FT. SPAN.

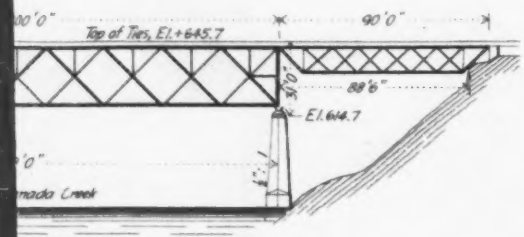








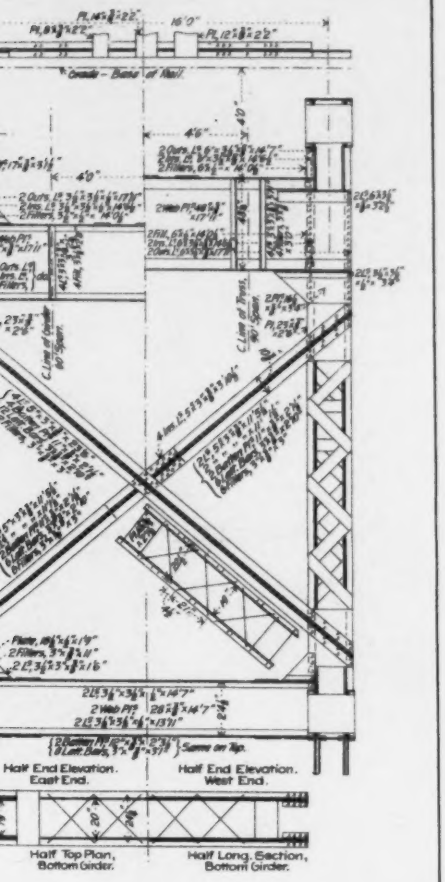
DETAILS OF 60-FT. SPAN.

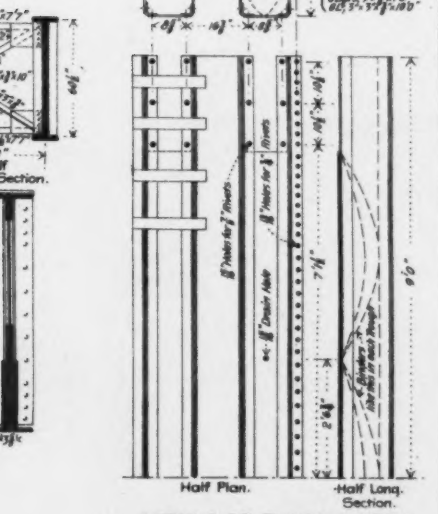


AL ELEVATION

TRENTON FALLS BRIDGE; ADIRONDACK & ST. LAWRE

Geo. H. Thomson, Designing Engineer.





DETAILS OF FLOOR SYSTEM
FOR 200-FT. SPAN.

LAWRENCE R. R.

er.

CHAS. HART & SONS, LITH, 99 VESEY ST., N. Y.

dividends have been diluted, for the same net earnings have to be spread over a larger capital. Now, it will surely not be denied that, if, instead of two trains each weighing 150 tons, we can run one train weighing 300 tons, or, even, if instead of four trains of 150 tons we can run three trains, each weighing 200 tons, we economise room on the line, and so make it possible to put off the evil day when the cost of doubling must be faced. Further, it is, I think, undeniable that the big American engines—extravagant coal burners though they no doubt are—could at least take loads of 200 tons at speeds which limit our smaller English engines to 150 tons. My point is that an American engine can take loads that our engines cannot take at the same speed. Consequently, their trains add new cars when the traffic increases, while our trains are divided. To take a concrete instance. The increased traffic to Buffalo means an extra car on the Empire State express The increased traffic to Edinburgh from Euston (London) meant the banishment of the Perth passengers from the 10 o'clock, and the establishment of an independent train for them at 10:30.

It surely needs no detailed timetables nor actual figures to show that, for instance, it would save room on the Great Northern line if the 9:45, 10:00 and 10:15 a. m.—all of which run over the same road for 130 miles, and stop practically only for locomotive purposes—could be compressed into two trains, or if the same course could be taken with the 1:30, the 2:00, and 2:30 in the afternoon. Or, again, to take a still more obvious instance, the London, Brighton & South Coast Ry., when accused of excluding third-class passengers from its expresses, defends itself on the ground that this would make their weight excessive, and that there is no room at certain hours for additional trains on the line between Croydon and Redhill. But if the Brighton company would send to the Michigan Central it would be able to borrow an engine that could take 375 tons at an inclusive speed of 37 miles an hour. In other words, such an engine would be able to haul from 30 to 35 ordinary Brighton cars, and yet enable the Brighton management to knock five minutes off the time of the 10 o'clock down, which at present is described as "first class limited."

I hope now I have made myself intelligible. When you say, "We can in this country haul a ton of grain or coal a mile at a higher speed with a smaller consumption of fuel than any American locomotive," I am not concerned to differ from you. I only reply that the object of the locomotive's existence is not to burn coal economically, but to carry traffic economically; and that, in so far as English locomotives by their lack of power tend to the undue multiplication of trains, and the consequent undue occupation of immensely valuable roads, they are extravagant traffic instruments. Finally, as I have ventured to differ from you on so many points, I would ask permission to express my entire sympathy with the wise words which you used in your last week's leading article on "The Future of the Atlantic," as follows: "There is in the Anglo-Saxon temperament a sort of smug self-sufficiency, which shows very strongly in all matters connected with foreign countries.—We talk, and then we go to sleep for a time, comforted and made happy by a phrase.—This unhappy fit of self-complacence is a cause for serious concern in many branches of our national autonomy. Facts will have to be faced fairly and openly, however, unpleasant their revelations of supineness and indolence may be." Here is one fact: In my travels on the Continent, I have noticed, whether it was in Sweden, in Holland or in Italy, that the old engines came from England, the new ones are by Belgian or Swiss or German makers. Reading tells me that in Mexico, in South America, in Canada and in Australia, the United States engine builders are crowding out our English productions. Is it not possible that one at least of the causes is the fact that railway men outside England do not attach quite as much importance to economical coal burning as we do, and prefer an instrument which enables the traffic to be economically worked as a whole? Is it not possible even that they are right in their preference?

As we have already stated, the Empire State express (which the "Engineer" takes for comparison because somebody else has instanced it, not because it knows anything about American railways) is, in the first place, by far the lightest of any fast express over the New York Central R. R.; and, in the second place, by far the fastest train in the world, even without considering the great length of its run. Therefore, it cannot be claimed for the Great Northern or any other English line that its train speeds are "certainly not inferior" to the American train. As to weight, the Great Northern trains of 240 tons (200 net tons) in summer and 180 tons (201.6 net tons) in winter, are not only far exceeded by all but one or two of the New York Central expresses, but are exceeded also by one or more regular expresses on all American lines of any prominence, since such weights are not here considered heavy trains at all. These facts, and the figures which we give below, show the absurdity of the statement that "the lightest express trains on the Great Northern weigh almost as much as the heaviest" on the New York Central."

That the "Engineer" is not alone in making misstatements in regard to American railways was shown by the letter from an English engineer in our issue of Feb. 16, in which he drew deductions from comparisons of a light American four-car express train of 485,000 lbs. (242.5 net tons) total load, and an English heavy express train of 695,000 lbs. (347.5 net tons) total load. In commenting upon that communication we presented particulars of regular heavy express trains on the New York Central R. R., and since then we have received from Mr. S. D. Casanave, General Superintendent of Motive Power, Pennsylvania R. R., the particulars of several regular high-speed expresses on that road, both light and heavy, which we give in full.

Train No. 59, Philadelphia to Washington (Philadelphia, Wilmington & Baltimore R. R.)—Locomotive, Class P, simple; cylinders, 18½×24 ins.; driving wheels, 5 ft. 8 ins. diameter; weight of engine and tender, 176,000 lbs. (88 net tons). Train: 1 combined passenger and baggage car, 1 dining car, 3 parlor cars; 5 cars; weight of cars, 445,000 lbs. (222.5 net tons). Total weight of train, 621,000 lbs. (310.5 net tons). The average schedule speed, Gray's Ferry to Washington, 134.1 miles, is 46.2 miles per hour, with stops at Wilmington and Baltimore. The schedule road speed, excluding time and distance through Wilmington, Baltimore and Washington, is 51 miles per hour for 123.9 miles. On the best run made between Jan. 17 and Feb. 6, 1893, the average speed between Gray's Ferry and Washington was 49.5 miles per hour, and the road speed 55 miles per hour between stops.

Train No. 2, Pittsburg to Altoona, (P. R. R.)—Locomotive: Class P, simple; cylinders, 18½×24 ins.; driving wheels, 5 ft. 8 ins. diameter; weight of engine and tender, 176,000 lbs. (88 net tons). Train: 1 Pullman composite car, 1 Pullman dining car, 3 Pullman sleeping cars, 1 Pullman observation car; 6 cars; weight of cars, 585,000 lbs. (292.5 net tons.) Total weight of train, 761,000 lbs. (380.5 net tons). Distance, 117 miles. Average speed, 35 miles per hour; maximum speed, 50 miles per hour; time made up, 26 minutes.

Train No. 22, Altoona to Harrisburg (P. R. R.).—Locomotive: Class O, simple; cylinders, 18×24 ins.; driving wheels, 5 ft. 8 ins. diameter; weight of locomotive and tender, 171,650 lbs. (85.82 net tons). Train: 1 combined passenger and baggage car, 2 passenger cars, 1 dining car, 7 Pullman sleeping cars; 11 cars; weight of cars, 864,500 lbs. (432.25 net tons). Total weight of train, 1,036,150 lbs. (518 net tons) Distance, 132 miles. Average speed, 43 miles per hour; time made up 14 minutes.

Train No. 5, Jersey City to Philadelphia (P. R. R.); Pennsylvania Limited, New York to Chicago.—Locomotive: Class P, simple; cylinders, 18½×24 ins; driving wheels, 5 ft. 8 ins.; weight of locomotive and tender, 176,000 lbs. (88 net tons). Train: 1 Pullman dining car, 1 Pullman composite car, 3 Pullman sleeping cars; 5 cars; weight of cars, 474,490 lbs. (237.25 net tons). Total weight of train 650,490 lbs. (325.25 net tons). Distance, 90.76 miles. Schedule or average speed, 45.12 miles per hour. Maximum speed, 57.60 miles per hour.

Train No. 20, Philadelphia to Jersey City (P. R. R.)—Locomotive; Class P, simple; cylinders, 18½×24 ins.; driving wheels, 5 ft. 8 ins. in diameter; weight of engine and tender, 176,000 lbs. Train: 1 baggage car, 3 passenger cars, 5 express cars, 1 dining car, 1 Pullman parlor car, 1 Pullman sleeping car; 12 cars; weight of cars, 618,260 lbs. (309 net tons). Total weight of train, 794,260 lbs. (397.1 net tons). Distance, 90.76 miles. Schedule speed, 40.68 miles per hour; average speed, 42 miles per hour; maximum speed, 60.60 miles per hour.

Train No. 20, Philadelphia to Jersey City (P. R. R.)—Locomotive: Class P, simple; cylinders, 18½×24 ins.; driving wheels, 5 ft. 8 ins. diameter; weight of engine and tender, 176,000 lbs. (88 net tons). Train: 1 combined passenger and baggage car, 2 mail cars, 1 dining car, 2 passenger cars, 3 Pullman sleeping cars; 9 cars; weight of cars, 640,606 lbs. (320.3 net tons). Total weight of train, 816,606 lbs. (408.3 tons). Distance, 90.76 miles. Schedule speed, 40.68 miles per hour; average speed, 39.48 miles per hour; maximum speed, 73.20 miles per hour.

In all the above cases the weights are exclusive of passengers and baggage. The figures given are official, and for heavy work show ordinary eight-wheel engines, with four-coupled wheels and eight-wheel tenders, hauling regularly train loads of 300 to 320 net tons behind the tender at average speeds of 40 to 42 miles per hour, and attaining speeds of 60 to 73 miles per hour. To make the matter still more conclusive, however, we add the following particulars of train No. 5, the Fast Western Express, from New York to Chicago, which is the heaviest regular express train on the New York Central & Hudson River R. R. This train leaves the Grand Central Station, New York, every day at 6 p. m., and averages as many as 13 cars. It is hauled by an eight-wheel engine. With 12 cars the train is made up as follows, according to particulars for which we are indebted to Mr. William Buchanan, Superintendent of Motive Power and Rolling Stock:

	Lbs.
1 drawing-room car	75,000
1 dining car	88,000
7 sleeping cars (85,000 lbs., 86,000 lbs., 94,800 lbs., 95,000 lbs., and three of 90,000 lbs.)	631,100
2 passenger day cars (60,200 lbs., and 49,000 lbs.)	109,200
1 baggage car	47,500
Total	950,800

This represents a train weight of 475.4 net tons (424.4 gross tons of 2,240 lbs.) behind the tender, exclusive of weight of passengers and baggage. The eight-wheel engine and its tender weigh together about 100 net tons. The speed is about 40 miles per hour, but sometimes averages 55 or 60 miles per hour, which, considering the weight of the train, is something remarkable. As another instance of a high-speed heavy train, Mr. Buchanan states that on Oct. 19, 1892, the Southwestern Limited Express, eastbound, No. 18, left Syracuse, N. Y., 43 minutes late (11:23, instead of 10:40 a. m.), and after one stop at Utica, arrived at Albany at 2:10 p. m., on time, having made the 147½ miles in 2 hours 47 minutes, or at the average rate of nearly 53 miles per hour for the entire distance. This train weighed 359.5 net tons (321 gross tons) behind the tender, and was made up as follows:

5 sleeping cars	475,000 lbs.
2 day passenger cars	164,000 "
1 combination car	80,000 "
8 total	719,000 lbs.

The above details, furnished us by official sources, indisputably dispose of the assertion that light English trains are as heavy as heavy American trains. They also dispose of the claims sometimes made, even on this side of the Atlantic, for the superiority of locomotives with a single pair of driving wheels, since the fastest and heaviest trains in the world are hauled by eight-wheel engines, which have a reserve power for emergencies not possessed by the single driver engines, although it is not to be doubted that the latter show very excellent service with fast trains of comparatively light weight.

So far the discussion has been only on the question of passenger trains, but a more important matter for English railways is the power of freight locomotives, particularly those for mineral traffic. For the ordinary freight trains the present engines (almost invariably with six wheels, all coupled, as shown in Eng. News, March 28, 1891) are of sufficient capacity. But many of the roads are hampered by the enormous coal traffic, and if these trains could be doubled up, and so reduced in number, it would much facilitate the handling of other traffic. It is true that with the present cars and their couplings, it would be difficult to do this, but it is for just this sort of traffic that the American type of freight car, which is being slowly introduced in England and other European countries (Eng. News, April 28, 1892, and Feb. 16, 1893) is most particularly suited. An engine with eight wheels, all coupled, has recently been built by the London & Northwestern Ry. for its mineral traffic (Eng. News, Jan. 12, 1893), and similar engines have for some years been in use on the South Wales coal lines, while the Great Eastern Ry. has some freight engines of the mogul type (Eng. News, March 14, 1891).

As to the relative proportions of live load to dead load in the American and English express trains,

there is little doubt that the former have a much greater dead load per passenger, the cars being of heavier and more substantial construction. It is probable that in the parlor cars, dining cars and sleeping cars this proportion is carried to excess in order to provide an easy riding car and to exclude all noise, but many of the English cars are so light as to be very rough riding and very noisy, there being only a single plank floor. English saloon cars and the differences between English and American passenger cars were discussed in our issue of March 23, and English railways are only now beginning to see that comfort, convenience and luxury are, when within reasonable limits, paying investments. Until recent years these railways have considered anything good enough for a railway car that would seat passengers, though they have discriminated in favor of the first-class passengers. That such provisions for comfort and convenience do pay has long been recognized here, though it must be confessed that the luxury, mainly in the interior fitting and decoration of cars, has been carried to excess in many cases. Present indications show that there is a growing tendency in England to provide more efficient lighting and heating and better accommodations for railway passengers, and the railways will doubtless recognize the benefits which accrue to them for thus caring for their passengers. In another column we give some particulars of the proportions of passengers in the different classes of European railway.

WHAT SHALL WE DO WITH OUR RAIL MILLS?

There is no form of finished iron or steel which is produced at so small a cost and is sold at so low a price as the steel rail. To trace the reason for this we must turn backward some distance in the history of iron and steel manufacture. A score of years ago the total production of all forms of rolled iron and steel in this country was about 2,000,000 tons, and of this nearly one-half was in the form of rails. At that date Bessemer steel manufacture had just begun; five-sixths of the rails rolled in the United States in 1873 were iron rails. The market prices of rails at that time, reduced to a gold basis, were $68 per ton for iron rails and $108 for steel rails. The enormous profits which these prices afforded to railmakers led to the rapid establishment of Bessemer plants and rail mills, and in ten years the relative positions of steel rails and iron rails had been reversed. In 1873 there were rolled seven times as many iron rails as steel rails. In 1883 there were rolled 20 times as many steel rails as iron rails.

In the decade since 1883 a progress no less marvelous has been made. Such of the early Bessemer establishments as were unfavorably situated geographically or were financially weak have gradually dropped out of the race. The well planned, well managed and wisely located plants, on the other hand, have reaped princely profits from the start, and have undergone a marvelous expansion. At the same time constant improvements in machinery and process have been made, with the effect of enormously increasing the output from a Bessemer plant of a given size, and decreasing the cost of its output.

In the most modern and best equipped of these plants the process of rail manufacture is a continuous one from the time the ore enters the blast furnace mouth until the finished rail is placed on the stock pile. Labor-saving machinery is introduced at every point, waste of fuel and material and wear of machinery are reduced to their lowest terms. Thus, with a plant working continuously at its full capacity it is possible to turn out rails at a total cost of from $20 to $25 per ton, according to the best and most reliable authorities.

Had competition had free scope in the steel rail trade, its record would not be one of such uninterrupted prosperity. But before the producing capacity overtook the demand, consolidation had made rapid strides, and the few producers which controlled the market had reached an understanding by which the selling price has been continuously maintained at a point which pays a handsome profit to the manufacturers. With the steady improvement in the processes and machinery and reduction in cost of production, the selling price steadily declined until in 1884 it reached $30.75 per ton. Since that time prices have been maintained at $29 to $30 per ton, except in 1886 and 1887, when a very heavy demand, caused by a heavy mileage of railway construction, permitted prices to be run up to $34 to $37 per ton.

Briefly, then, what has gone on in the steel rail industry is this: An enormous increase in the productive capacity of existing plants, coupled with their extension and with the construction of new works by those who were aware of the heavy profits which were to be made in the business. The natural result has been that the productive capacity has far outstripped the demand; and while steel rails are produced to-day on a larger scale and at a less cost than any other form of finished iron or steel, they are a drug in the market, and the mills which produce them are not run at anything like their full capacity.

To see how largely the productive capacity is in excess of the demand the following figures are of interest:

The rail mills of the six great companies which control the steel rail market have the following capacities, according to the "Directory" published by the Iron and Steel Association:

	Annual capacity, gross tons.
Illinois Steel Co. (four works)	925,000
Carnegie Steel Co. (two works)	590,000
Pa. Steel Co.; Md. Steel Co. (two works)	445,000
Lackawanna Iron & Steel Co. (two works)	445,000
Bethlehem Iron Co.	200,000
Cambria Iron Co.	200,000
Total.	2,805,000

Besides these large plants there are rail mills at Troy, Cleveland, Springfield, Ill., and Pueblo, Colo., whose united capacities, according to the same authority, is over 420,000 gross tons. All these, except the Cleveland works, are less favorably situated to secure supplies of ore and fuel than the larger works given above. On the other hand, this is to some degree offset by the advantage in the local markets due to freight charges on rails from the works more favorably located. Thus their productive capacity cannot be fairly left out of the account.

It appears, then, that the productive capacity of the steel rail mills of the country at the present time, making reasonable deductions for idleness due to accidents, repairs, labor troubles, etc., is about 3,000,000 gross tons per annum.

In 1887 the greatest consumption of steel rails on record was reached, the total for the year amounting to 2,277,000 tons. This figure has not been approached since, the average consumption for the five years since 1887 having been in round numbers 1,500,000 tons. The large excess of producing capacity over demand has had no effect on prices. The orders have been divided up among the different companies, and as a result each of the mills has been idle a considerable percentage of the time, or has marketed its output in the form of ingots or billets instead of rails.

An examination of statistics shows that the demand for steel rails is not likely to overtake the producing capacity for many years. According to Poor's Manual, the annual increase in the railway trackage of the United States, including second, third and fourth tracks, sidings, etc., has averaged 9,259 miles per year for the past 10 years. Estimating the average weight of rails purchased at the present time at 70 lbs., this accounts for an annual average consumption of 1,018,490 tons. Of course, some part of this tonnage really represents rails purchased for renewals, the old rails being made use of in extending sidings and spur tracks, which are included in the figures for extension of trackage.

Let us allow, however, that in round numbers 1,000,000 tons represents the average annual requirement for extensions. This leaves then but 500,000 tons as the average annual requirement for renewals at the present time. If we estimate the average weight of rails used for renewals at 70 lbs., this represents an annual relaying of 4,550 miles of track.

There are now in the United States some 215,000 miles of railway track, including sidings and additional tracks. What the average life of this whole mileage is or is to be is a difficult matter to estimate. The figures above show that only about 2% per annum is, at present, being renewed; but certainly 50 years is far above the average life of the steel rails on all tracks, taking the country at large. Steel rails in heavy service may wear out in ten or twelve years; and the steady growth of traffic all over the country is constantly increasing the rate of wear of rails everywhere. On the other hand, 35,000 miles of the total mileage above given is sidings and yard tracks, on which the wear is very small; and a very large portion of our single track mileage has, as is well known, so little traffic over it that its life is bound to be a long one. Everybody knows that no one is buying rails to renew tracks of this sort, and no one is likely to for some years to come. Again, it is a fact not often realized that one-half the total mileage of track now laid has been put down since 1880. Certainly requirements for renewals of rails on these recently built roads are not likely to cut any figure in the rail market for many years to come.

These things lead to the conclusion that while the average life of the rails now in service may be perhaps 25 to 33 years, and the demand for renewals may eventually amount to 700,000 to 1,000,000 tons per annum; at the present time the consumption of about 500,000 tons per annum for renewals, plus the tonnage included in extensions which is really used for renewals, fairly represents the demand which is likely to exist for some years to come.

It may be said that the great extension of electric railways may make a material addition to the demand. But, after all, these cut a small figure compared with requirements of steam railways. The total mileage of street railways was increased last year about 1,000 miles, and making all allowances for renewals of track where horse railways were changed to electric, not over 1,500 miles of street rails were used. At 70 lbs. per yd. this means a consumption of 165,000 tons of rails; but a large proportion of this is furnished by mills which make a specialty of street rails, and are not included in the list of rail mills given above. The very considerable mileage of logging and other private railways may also be mentioned as a factor of importance in estimating the probable demand; but these are largely laid with second-hand rails or with rails of very light section, so the tonnage does not cut very much of a figure.

The conclusion seems to be inevitable then, that the consumption of steel rails in this country for some years to come is likely to be between the limits of 1,500,000 tons and 2,000,000 tons at the outside. The rail producing capacity, as we have seen above, is largely in excess of this; and the question arises, in view of the fact that steel rails are sold at a lower price than any other finished form of iron or steel, what outlet can be found for the surplus product. It is of interest to see how much cheaper rails are than other forms of iron and steel. The following represents current market prices:

	Cts. per lb.
Steel rails, standard sections	1.20
Street rails	1.43 to 1.61
Beams and channels	1.75 " 1.80
Angles	1.65 " 1.70
Z-bars	1.85 " 1.90
Tees	1.90 " 2.00
Plates	1.65 " 1.80

Notwithstanding the considerably higher prices realized for other forms of steel it is probably safe to say that the profits realized are less on them than on rails. This results from the enormous output of the latter, and from the special facilities which have been developed for their production.

If steel beams were produced in the same quantities as steel rails, there is no apparent reason why they should cost very much more for sections of approximately the same weight. The few more passes through the rolls which a beam requires would be well paid for by the addition of a very small fraction of a cent per pound; whereas, as shown above, beams now cost over one-third more than rails.

Is it not worth while inquiring, then, whether engineers might not make a much larger use of steel rails in construction, either in the sections rolled at present or in variations which could easily be rolled by the rail mills? The ordinary sections of rail are not as deep as would be desirable for their use as columns or beams, but girder rails of 6, 7, 8, 9 and even 10 ins. depth are now being rolled for street railway purposes. Certainly rails of this depth are by no means ill suited for structural purposes, so far as their form is concerned, at least.

It may be argued that Bessemer metal is less reliable than open-hearth; but it must be remembered that a large amount of structural shapes are already rolled from steel made in the Bessemer converter; and although open-hearth material will generally be specified where relibability is very important, there are many places where Bessemer steel may justly be permitted. In view of the enormous use of Bessemer steel in rails, it cannot justly be called a treacherous metal.

Nor is the use of rails for structural purposes by any means a new thing. Their use in the concrete foundations of Chicago's tall office buildings is familiar to engineers, and may profitably be copied wherever similar conditions exist. The extensive buildings of the Maryland Steel Co., at Sparrows Point, Md., are all built with columns made of rails bolted together, and rails are used for compression members throughout the framing. Isolated instances of the use of rails in repairs or for temporary structures on railway works are within the experience of almost every engineer.

It is worth while inquiring whether if I-beams of, say, 6 ins. to 8 ins. depth could be rolled on the rail mills, they might not find an extensive market as floor beams in fireproof construction. Many engineers who would hesitate to use Bessemer steel for columns or girders would be willing to use it for floor beams if 30% in cost could be saved thereby; and it must certainly be admitted that if a steel rail is safe to carry high-speed passenger trains, it is certainly safe under proper load for use as a floor beam in an office building.

The reduction of 30% in cost, if it could be realized, ought to do very much to stimulate the use of fireproof construction. Notwithstanding the great advance which the last ten years has witnessed in the discarding of wood and the adoption of incombustible materials in construction, only a beginning has been made in this work. The present low prices for steel are bound to give a great impetus to it, and if a further reduction can be made by the utilization of the extra capacity of the rail mills of the country there will be still further inducements to discard the old-fashioned conflagration-inviting system of construction in every building of importance.

Of course, in all this discussion the fact is not to be lost sight of that the rail manufacturers themselves are likely to do with their rail mills whatever they conceive to be for their interests. They may argue that to roll beams on their mills and sell them at the price of rails would injure their regular market for beams. Doubtless this would be true to some extent; but, on the other hand, the competition would be only in the smaller sizes of beams, and it seems not unlikely that the decreased cost would cause an eventual stimulus to fireproof construction, and a broadening of the market which would more than make up for any temporary loss.

The total number of vessels in the British mercantile marine, say Lloyd's latest returns, is 21,542, with an aggregate tonnage of 12,203,761 tons. Of this number 7,960 are steamers with 8,980,203 gross tons, or an average considerably over 1,000 tons each. Last year England added 872 vessels of 984,670 tons, of which 21,000 tons were purchased from foreigners. But England also sold to foreign nations, chiefly Norway, France and Germany, 117,000 tons more than she purchased. In the last 6 years nearly 4½ million tons of steamers have been added to the register, and only 1.6 million tons have been removed; and of the latter the greater number have only changed flags and are still competitors for trade. In the same period 913,000 tons of sailing ships have been added on 1,206,000 tons removed; so that there are fewer sailing ships on the register now than in 1887.

An electric power transmission over a distance of 23 miles is projected at Seattle, Wash., by Mr. B. P. Lacy, President of the Parke & Lacy Co., of San Francisco. He proposes to utilize the water power of Snoqualmie Falls, where the available head is 268 ft., and the volume of water is sufficient to generate 10,000 to 15,000 HP. Pelton wheels will probably be used to drive dynamos and the electricity will be transmitted at high potential to Seattle where it will be utilized as desired.

Philadelphia has now about 370 miles of telegraph and telephone cables, and 22 miles of electric light cables laid in subways. The total mileage of subway ducts is about 150.

LETTERS TO THE EDITOR.

TAR FOR PRESERVING TIMBER.

Sir: Your correspondent S. D. K. (Eng. News, April 6) will find an answer to his inquiry regarding a method for preserving timber by the use of coal tar in Wheeler's "Civil Engineering," pages 12 and 13. There are two methods described, as follows:

1. Ringold and Earle invented the following process: A hole from ½ to 2 ins. diameter was made the whole length of the piece, and the timber boiled from two to four hours in limewater. After the piece was dried, the hole was filled with lime and coal tar. This method was not very successful.

2. Robbins' process consisted in treating timber with coal tar in the form of vapor. The wood was placed in an airtight iron chamber, with which was connected a still or retort, over a furnace. The furnace was then fired and the wood kept exposed to the heated vapors of the coal tar from six to twelve hours; the operation being then considered complete.

Chas. H. Vanderbilt.

White Plains, N. Y., April 8, 1893.

OVERHEAD VS. UNDERGROUND WIRES.

Sir: Your record of the experience with electrical subways in New York city which is given in your issue of April 6 is very fair to both sides, and the conclusions which you draw are correct. As to the reliability of service of overhead and underground circuits, the two systems are not comparable, and the electric light people frankly confess it. In your estimate of the cost of the subway, you have made no mention of the first cost of poles, cross-arms, insulators, etc., for the overhead system. It may be roughly assumed, however, that the cost of the underground cables will offset this. The virtually compulsory renewal of overhead lines about once in 10 years, as against, it may be, once in 25, 50 or even 100 years, in the case of the underground wires, is one of the strongest points in favor of the underground system.

Yours truly.

New York, April 10, 1893. W. M.

LENGTH OF FLANGE PLATE FOR PLATE GIRDERS.

Sir: Following find formula giving theoretical length of flange plate for a plate-girder. I have seen no notice elsewhere of this method and hope it may prove of interest to the profession.

It is assumed that the unit flange stress has been determined upon, and that the designer has found the maximum moment and required section of angles and plates at the center.

Let s = allowed unit stress, l = span, d = depth, w = sum of dead and equivalent live loads per linear foot, A = area of portion of flange inside of plate whose length is to be found. This area will ordinarily consist of one-sixth of web, of flange angles, and of plates inside of plate in question.

M = bending moment at point distant x from left end, this being the point where flange must be reinforced, or the theoretical end of plate in question.

Then at this point, As = total allowed flange stress, and M = Asd;

but $$M = \frac{w\,l\,x}{2} - \frac{w\,x^2}{2};$$

hence $$\frac{w\,l\,x}{2} - \frac{w\,x^2}{2} = A\,s\,d,$$

and $$x = \frac{l}{2} \pm \sqrt{\frac{l^2}{4} - \frac{2\,d\,s}{w}\,A}.$$

The two values of x give distances of ends of plate from left end. By subtracting the less value from the greater, the theoretical length of plate is found to be

$$\sqrt{l^2 - \frac{8\,d\,s}{w}\,A}.$$

It will be noticed that l, d and w are constant for any one girder, s for any one flange, and A is easily found, the section at center having been previously obtained. In practice it is customary to increase the theoretical length sufficiently to embrace rivets enough to transmit all the stress that can be carried by the plate. This, however, seems to the writer to be unnecessary.

Yours truly, R. C. Berkeley, Jr.

Chicago, Ill., March 24, 1893.

STRENGTH OF CEMENT.

Sir: I send you herewith, a paper read, April 5, before the American Society of Civil Engineers, upon the Sodom Dam. On page 6 you will notice some tables as to the natural and Portland cement used on the dam, and as these are the longest time records on Portland cement in the United States, and unless I am mistaken in the world, I thought they might be interesting to you.

In the discussion of the paper before the Society, it was stated that 85% of the Portland used was of the "Giant" brand and 15% was of the Burham, English cement. The "Union" cement, which is stated to be a Rosendale, was also explained in the discussion as being a natural American cement, not made in the Rosendale district, but made at Egypt, Leigh Co., Pa. Both the "Giant" (Portland) and the "Union" (natural) cements were made by the American Cement Co., who also furnished all of the Portland cement ("Giant" brand) which was used in the brickwork lining the tunnel of the Cataract Construction Co., at Niagara Falls.

Yours truly,

Lesley & Trinkle,

Philadelphia, Pa., April 6, 1893. Sales Agents.

(An abstract of the paper referred to was given in our issue of April 6, and we give below the table referred to by our correspondent.—Ed.).

Of the entire bulk of rubble the larger part was in 1 to 2 Portland cement mortar, the remainder being in 1 to 3 Portland, and a small amount of 1 to 2 American cement. All the facing stone and dimension stone masonry is laid in 1 to 2 Portland cement mortar. The cement used was "Burham" (English) and "Giant" (American) Portland cements, and "Union" (American) Rosendale cement.

A careful test was made of all cements used, under the following requirements:

	Tensile strength required in lbs.	
Portland cement.	One day.	One week.
Tensile strain, neat	110	300
1 to 2 mortars	...	100

Fineness; 80% must pass through a sieve of 10,000 mesh. The following are some of the results obtained from these tests:

Average Tensile Strength in Pounds.

	Time set in water.						
Brand.	1 day.	1 wk.	1 mon.	1 yr.	2 yrs.	3 yrs.	4 yrs.
Portland.							
Burham, neat	167	429	615	708	700	764	782
" 1 to 2 mortar.	...	141	258	468	532	632	658
" 1 to 3 mortar.	...	169	224	404	520	552	...
Giant, neat	140	348	422	682	694	736	771
" 1 to 2	...	166	280	490	564	680	674
" 1 to 3	...	140	234	420	512	572	...
Rosendale.							
Union, neat	160	240	228	510	542	650	654
" 1 to 2	...	34	94	394	430	514	522

RELATIVE LENGTH OF STEEL TAPES.

Sir: In 1873, in consequence of numerous inquiries we had received as to the degree of accuracy of the imported English steel tapes, we tested at one time, and under the same conditions, some fifty of these tapes, and found that they were all (with two exceptions) too short as compared with the U. S. standard, procured from the U. S. Bureau of Weights and Measures at Washington. The 50-ft. tapes were from 2-100 to 3-100, and the 100-ft. from 4-100 to 6-100, of a foot too short. This was about 20 years ago (February, 1873), and at the suggestion of Jno. C. Trautwine, we published, for the information of those interested, the results of these tape tests in our pamphlet, "Remarks on Engineers' Surveying Instruments," the first edition of which was then just preparing for press. Many engineers then took advantage of our offer of testing any tape sent us, and we furnished the variation (if any) from the U. S. standard. The foreign makers of these tapes were notified of the differences, and of late years these imported steel tapes have been made nearer the U. S. standard. The earlier differences have been removed, and the majority of them are now practically correct. Within the last two weeks we have had occasion to test six of these 100-ft. steel tapes, and found no error in any of them, and if there is an error at the present time, it is in their being slightly longer than the U. S. Standard.

Our experience with the steel tapes made in this country, as compared with the imported, is that the U. S. make are more correct; that is, they agree more closely with themselves, and with the U. S. standard, and, if our sales are any judge, are largely taking the place of the imported tapes.

Regarding Mr. Berry's English steel tape, we test all tapes with the U. S. standard and give purchasers a note of comparison (if any); if at the time of purchase Mr. Berry received no such note, we found it correct with the U. S. standard; this will also explain why this particular tape agreed with the K & E tape.

In the present edition of our "Remarks," an explanatory foot note states, "that the English tape is more correct at the present time than when this statement was written." We have not removed the statement, as many of the earlier steel tapes are still sent to us for comparison, in consequence of this notice. Yours truly,

Chas. S. Heller.

(Heller & Brightly.)

Philadelphia, April 6, 1893.

NOTES AND QUERIES.

Mr. F. H. Crafts, 21 Reynolds Arcade, Rochester, N. Y., wishes to know who has been furnishing, or who can furnish, very finely broken granite, for use in Portland cement walks, at Buffalo, N. Y.

REBUILDING A DEFECTIVE BRIDGE PIER.

The work of removing a defective masonry pier of a railway bridge and rebuilding a new pier without interfering with the traffic over the bridge is of no small importance, and calls for considerable engineering skill and care in its proper and safe execution. We illustrate in the accompanying cuts a work of this character where the conditions were, to say the least, arduous, and the methods adopted in its accomplishment unusually simple and effective. The work referred to was

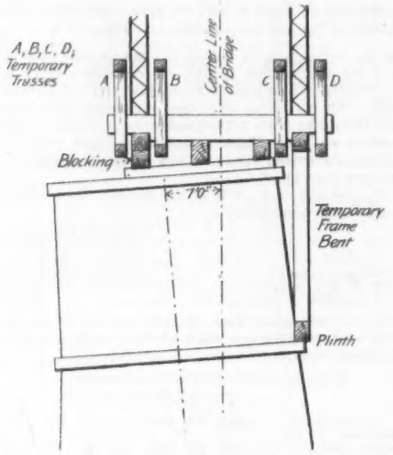


Fig. 1. Temporary Bent Supporting Swing Span During Erection of False Work.

the removal and rebuilding of the pivot pier of a 250-ft. swing span, forming one of the spans of the bridge carrying the Anniston & Cincinnati R. R. over the Coosa River at Gadsden, Ala.

The original pier was sunk into position in an ordinary water-tight caisson, the bottom of which was formed of two layers of 12-in. × 12-in. timbers, crossed at right angles and thoroughly spiked together. The plan of this caisson was octagonal, and the plan of the pier was circular. The pier built within the caisson was sunk onto what was supposed to be a solid ledge of rock in about 12 ft. of water at ordinary low water level. Owing to an error in judgment or insufficient examination of the foundation site, a layer of gravel was left under the pier, which was brought to light only by the tilting of the pier to one side, the pivot going down stream about 7 ft. and nearly throwing the swing span into the river. The accident occurred at an extraordinary high stage of water, the river being subject to a rise of nearly 40 ft. at this point.

An examination being made by a diver, it was discovered that the pier, instead of having been founded on a ledge of solid rock, as had been supposed, had been lowered onto a 4-ft. bed of gravel of a very compact nature, so compact, indeed, that it had proved impenetrable to the sounding rod of the engineer originally in charge of the bridge, and was supposed by him to be solid rock. The cushion of gravel had been scoured and cut away by the currents consequent upon the pier being placed in the river, and ultimately undermined sufficiently to throw the pier out of line, as described. Only one movement occurred, which left the pier leaning down stream apparently uninjured, as no signs of cracking or motion were visible anywhere in the masonry or joints, a fact which speaks well for the quality of the masonry work, whatever the original error may have been. The pier was closely watched from transit stations for further movement and, as none occurred, upon the water subsiding to a more ordinary stage, the swing span was thrown back as nearly as was possible to its original center line, which was to within about 2 ft.

Steps were then taken to place the dislocated span in condition for traffic pending the preparations for removing the pier. As the pier had gone so far out of line down stream, it was found necessary to erect a false bent to support the upstream side of the turntable. This bent rested on a check cut into the masonry of the pier at the level of the plinth, as shown in the accompanying sketch, Fig. 1. The downstream side of the drum was supported by blocking on the coping of the pier, after removing the pivot castings and all other turning gear attached to the masonry. This work being thoroughly tested the trains were allowed to pass over the span.

Preparatory to the work of demolishing the injured pier, it was necessary to erect a falsework to support the span. A cofferdam was first constructed around the pier, so as to give plenty of clearance to the old caisson. This dam gave a great deal of trouble during the prosecution of the work, owing to the porosity of the gravel, and to the irregularity of the surface of the rock upon which the gravel lay, although three separate rows of sheet piling were driven through it to the rock and well puddled between. Upon the completion of the cofferdam bents were erected on each side of the pier, resting on the cofferdam, to facilitate the handling of the swing-span. Foundation piles were then driven; one row inside of these bents and one row outside, on each side of the pier. These piles were driven solid to the rock, cut off and capped, and thoroughly braced to each other and to the dam. As a further precaution against knuckling, four heavy longitudinal girts were used, tieing these to separate sets of piles on each side of the pier, two or three on the upstream side and two or three on the downstream side. On these pile foundations four heavy frame bents, two on each side of the pier, were erected at right angles to the center line of the bridge, which were firmly braced together to form two separate temporary piers. These two temporary piers were 45 ft. apart, c. to c.

When this falsework was completed, four timber trusses were erected. These wooden trusses were placed, one on the inside and one on the outside, of each of the iron trusses of the swing-span, and so disposed that the drum, end and vertical posts of the swing-span should rest upon them. The shape of these trusses was governed by the position of the cross-girders carrying the pivot, and, also, by the floor beams of the iron span. The positions of the tension rods in the wooden trusses was, also, in a measure, governed by the positions of the ironwork of the iron structure. The general design of the completed falsework is shown in Figs. 2 and 3. After the temporary trusses were completed and the tension rods keyed up, the swing-span was slightly raised by means of hydraulic jacks and the temporary blocking and false bent, which carried the weight onto the masonry, were all lowered a few inches. The swing-span was then lowered onto the temporary trusses, the weight being uniformly distributed on the lower chords from the drum and center and end posts by careful blocking.

The full weight of the swing-span being now carried entirely by the falsework, it was thoroughly tested by running heavily loaded iron ore trains over the bridge. The deflection of the wooden trusses under this load proved to be very slight, and the vibration was scarcely perceptible. The only inconvenience sustained from the falsework in carrying on the traffic of the road was that due to the space occupied by the wooden trusses, which narrowed the clearance to 10 ft. 9 ins. This narrow clearance caused the scratching of the paint on two or three unusually wide private cars, but no greater damage.

The falsework proving satisfactory, work was at once commenced in removing the masonry of the tilted pier. This was done by means of two stationary derricks attached to the falsework and a floating derrick. All the masonry was lowered into barges, each course being numbered as it was removed; sent ashore, and there cleaned and conveniently piled for future use. The work was carried on day and night, electric lights being used for night work. After the masonry had been removed the timber grillage on which the pier had rested was broken up and removed. The gravel inside the cofferdam was then cleaned out down to solid rock, upon which the new pier was begun. New masonry was put in to supply the place occupied by the gravel and grillage, and then the old material was put back into its original position as nearly as possible. The height of the pier, from the rock to the top of the coping, was approximately 80 ft., and it contained 1,100 cu. yds. of masonry. This work was begun on Sept. 15, 1888, and the iron swing-span was again at rest on the new masonry on Dec. 25, during which time the work had been seriously retarded or two or three occasions by the river rising above the cofferdam. The swing-span was turned successfully on Jan. 5, 1892.

The credit of designing and carrying out the work is due to Mr. Cecil Fraser, of Louisville, Ky., who was the engineer in charge of the work, and to whom and Mr. S. G. Patterson, of Anniston, Ala., we are indebted for the matter from which our illustrations and the accompanying description have been prepared.

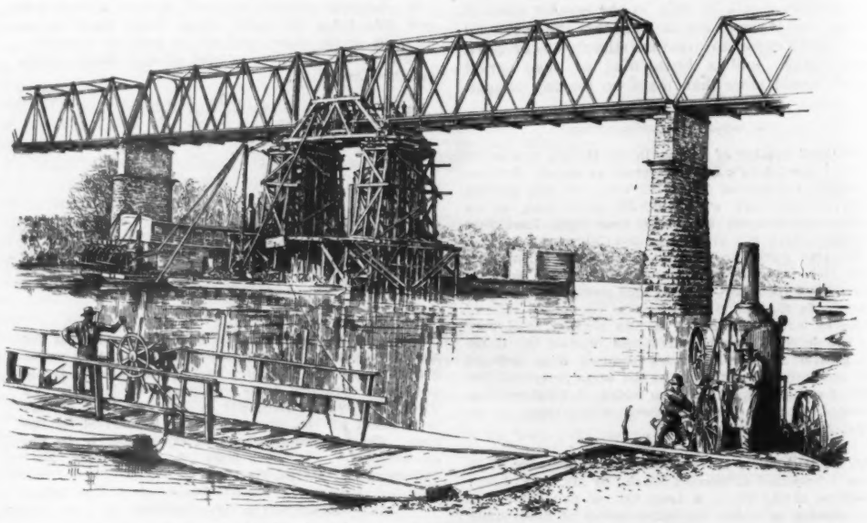


FIG. 3. GENERAL VIEW OF FALSE WORK AND SWING SPAN.

NOTES FROM THE ENGINEERING SCHOOLS.

Prof. Ward Baldwin, of the University of Cincinnati, sends us the following note in regard to various matters at that university not adequately shown in our late series of articles:

"I send you a few notes and corrections regarding the course in civil engineering of the University of Cincinnati, which institution, through no fault of yours, was rather incompletely noticed in your valuable articles on the "Engineering Schools of the United States." In Table XIII. it should not have been credited with a course in electrical engineering. In Table XIX., algebra through quadratics should have been included in the requirements for admission, making the total number of subjects in which examinations are required ten, instead of nine. In Table XX.

the degree given by the U. C. for a four years' course should have been B. S. Previous to 1891, the degree of C. E. was offered.

In Table XXVII. the number of graduates from 1860 to 1884, inclusive, is called the "potential" number of members of the American Society of Civil Engineers, and a comparison made between this "potential" number and the actual number of graduates who are now M. Am. Soc. C. E. This, as you are careful to say, may not be a fair criterion of the practical value of the instruction given at some colleges. This seems to be specially true in the case of the U. C. Of the 15 graduates included in the "potential" number credited to the U. C., two died shortly after they graduated, and four returned to their native country, Brazil. Of the remaining potential 9, one is a M. Am. Soc. C. E., and four others are unquestionably eligible: one is the chief engineer of a railway in Tennessee, and another of a road in Utah; one the chief engineer of an irrigation company in California; and one a consulting engineer in Denver. All four have held responsible positions for some years, and are successful engineers.

The distributions in Table XXXIII. should be:

Algebra. . .	48	Botany. . .	36
Trigonometry. .	48	Geology. . .	36
Analytics. .	84		
Desc. geom.	108	Total C.	540
Total A.	288	Astronomy. .	36
		Surveying. .	144
Calculus. .	234	Chemistry. .	144
Least sq.	18		
Mechanics. .	216	Total D.	324
Physics. .	144		
Electricity. .	72	Thermodynamics. .	72
		Drawing. .	198
Total B.	684	Eng. technicals.	252
French. .	216	Total E.	522
Eng. lit., etc.	252		

The distribution of time in weeks in Table XXXIV. should be:

A.	B.	C.	D.	E.	Total.
18	42	33	20	31	144

This last table brings out the prominence given to the higher mathematics. This instruction, under the able supervision of Dr. H. T. Eddy, now President of the Rose Polytechnic Institute, and Pro. E. W. Hyde, has afford us the room long needed for a more extensive engineering laboratory.

In closing, I beg to express my appreciation of the great benefits your arduous labors will confer upon all interested in technical education, and to compliment you upon your impartial and happy treatment of a subject that must have often been perplexingly delicate.

NOTES FROM CITY ENGINEERS' AND PUBLIC WORKS REPORTS.

A flush tank on the sewerage system of Laconia, N. H., is supplied with water from a small reservoir formed by damming a near-by stream. The tank discharges automatically every five minutes. Mr. Wm. Nelson is Superintendent of Sewers, and the above is from his last annual report.

The last annual report of Mr. L. M. Hastings, City Engineer of Cambridge Mass., contains a table giving the material, size and other details, including total cost, of the sewers built in Cambridge during the year ending Dec. 1, 1892. The cost per foot is not given.

The total cost of the sewerage system of Fitchburg, Mass., to Dec. 1, 1892, was $224,627. There were on that date 3.19 miles of brick sewers, ranging in size from 40×60 to 14×21 ins., and 16.03 miles of 24 to 8-in. pipe sewers, making a total of 19.22 miles. Mr. David A. Hartwell is city engineer.

A topographical map of the city of Pawtucket, R. I., compiled by Mr. Geo. A. Carpenter, City Engineer, is published in Mr. Carpenter's last annual report. The map is 1-6,000 full size, with 10-ft. contours over most of the city, and 2-ft. contours over a small section.

A steam hammer using the expansive force of the steam to strike the blow was used last year by the sewer commissioners of Pawtucket, R. I., to drive sheet-piling. In their last report the commissioners state that this was "probably the first steam hammer ever built for this purpose, striking a blow similar to a blow from a steam drill, that was made to work successfully."

This hammer was used in connection with the

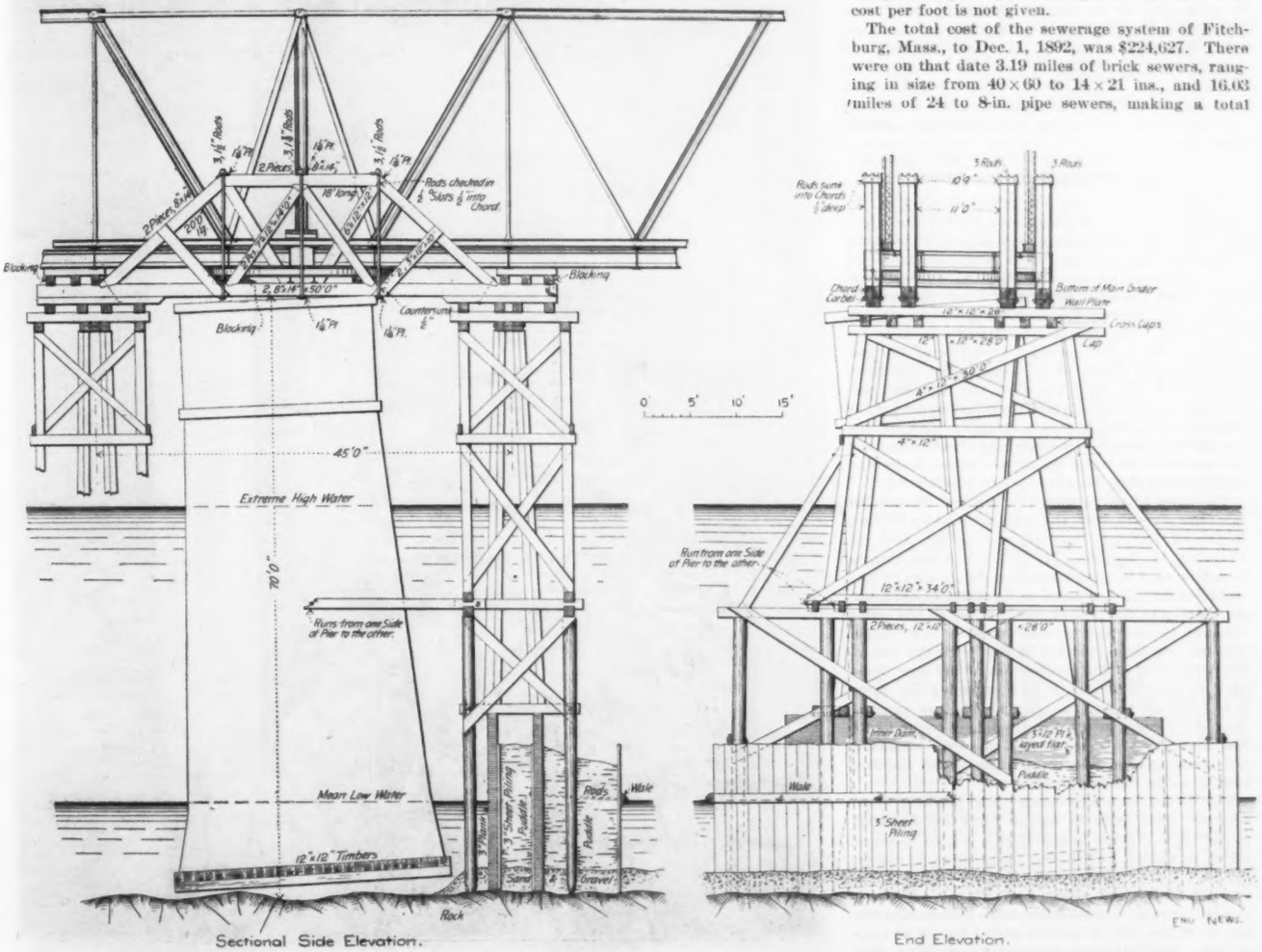


FIG .2. FALSE WORK FOR SUPPORTING THE SWING SPAN OF THE COOSA RIVER BRIDGE DURING REBUILDING OF MASONRY PIER.
Cecil Fraser, Designing Engineer.

The statistics of studies are perhaps as valuable as any others contained in your articles, and it is to be regretted that the returns have not all been made on the same basis. Although the student usually spends more time in the drafting room and laboratory than he is credited with; and this fact, together with the diverse methods of teaching, makes it impossible to determine the exact comparative value of the various courses of study; still, returns made on a uniform system would be most instructive. Adopting three hours in the laboratory, drafting room, or field, and one recitation or lecture as a unit, the division of time in Tables XXII. and XXIII. should be:

Kind of work.	Hours.	Weeks.	Per cent.
Recitations and lectures.	2,016	123	85.4
Laboratory and drafting.	306	19	13.2
Field.	36	2	1.4
Totals.	2,358	144	100.0

always been particularly thorough and comprehensive While we have regarded our course as strong theoretically, we have long recognized the need of a well equipped engineering laboratory. Expansion in this direction has been hindered partly by lack of room in our present building and partly by lack of funds. We are just now entering upon a new era in the history of our university. The plan of relocating the university in a more desirable neighborhood has long been cherished by the trustees, but legal obstacles have prevented the realization of this wish, until now the Supreme Court of Ohio has recently handed down a decision confirming the right to the trustees to move the university wherever they please. This decision enables the trustees to accept a tract of about 40 acres in Burnet Woods Park, given to the university by the city. Several buildings, one of which will be for the joint occupancy of the departments of physics and civil engineering, will be erected here at once; and will

construction of a sewer on Newell Ave., the flow line of which is 36 ft. below the ground surface. At 28 ft. below the surface water and running sand were found, necessitating the use of water-tight plank sheeting for the lower 10 ft. of excavation. The report states that it was found to be practically impossible to drive the sheeting with common mauls or with the man power dead drop hammers in use. A special steam hammer was designed in the sewer commissioner's office and built by the Ingersoll-Sergeant Drill Co., of New York city. The sheeting was left in place as driven. Mr. Issac Shove is chairman of the sewer commissioners, and Mr. A. R. Sweet, engineer.

As a contribution to arguments in favor of street improvements, Mr. R. A. Cairns, City Engineer, of Waterbury, Conn., presents in his last annual report two reproductions of photographs taken the same day of different sections of the same street, one recently paved with granite blocks and the other without paving.

Over 50% of the sewers of Albany, N. Y., according to the last report of Mr. Horace Andrews, City Engineer, are of the old square pattern, with plank bottoms. About 30% of the sewers are of vitrified pipe. Mr. Andrews' report includes some valuable statistical tables regarding the extent and character of the sewers and pavements of the city.

THE TEMPLE COURT FIRE.

There have been so few practical tests of the modern system of fireproof construction that there is much doubt and dispute as to the actual behavior of fireproofing materials when placed in actual use and subjected to the ordeal of a conflagration. This being the case, we are sure our readers will study with interest the accompanying engravings, reproduced from photographs taken especially for this journal, in the burned-out portion of the ten-story Temple Court office building, on Beekman St., New York city. We gave the principal particulars concerning this fire in our last issue; but the illustrations give a more graphic idea of the complete destruction wrought by the flames, and the condition in which walls, partitions, floors and ceilings were left, than words can possibly do.

The suite of offices shown in the first illustration is on the seventh floor, and was occupied by Messrs. Wilcox & Barkley, lawyers, and by Mr. Gus. C. Henning, M. Am. Soc. M. E. It is interesting to note how well the fireproofing on the column on the right foreground has stuck to its work. In not a single place was the iron exposed, although the outer layer of plaster has cracked off in a few places. One other column, located in line with the one in the foreground at the intersection of the first cross-partition, lost a section of its fireproofing for about 5 ft.; but as it was, on the whole, less exposed than the column in the foreground, it seems likely that it may have been knocked off in the smashing and crashing attending the putting out of the fire, instead of by the fire itself.

The ceiling in every room fully justifies those who pin their faith to hollow tiling for fireproof construction. There is practically not an instance where this tiling has broken away so as to expose the floor beams. There are a few breaks in it, especially where the upper part of the partitions abutted against it; and holes were broken into the hollow of the tiles in several cases; but in no case did any whole tile, or any section of tiling, fall from its place. It must be conceded, too, that this tiling held the plastering remarkably well. Considering how little real key there is between the two surfaces, it is rather surprising that much more plaster did not fall.

The upper part of the partition between the hall and the suites of offices was of glass, and it is this part which is seen to be missing in the photograph; probably this did much to facilitate the spread of the flames.

Partitions of three different materials are seen separating the rooms on the left. The two nearest to the point of view are built of blocks composed apparently of a mixture of ashes and plaster of paris. The plaster finish is laid directly upon this surface, and notwithstanding the absence of any "key" it seems to have stuck quite as well and perhaps better than it did on the hollow tile partitions, which are those principally used in the building. The partition wall seen through the doorway in the background is of brick and separates the newer portion of the building, which was burned out, from the older.

Our second illustration is from a photograph taken in a room across the hallway shown in the first view, and opening on an inner court of the building. The fact that the casings around the window openings are entirely gone, and the destruction wrought on the window ledge, is good evidence of the severity of the conflagration. The steam pipe covering in the corner has stood the heat of the fire in a very creditable manner; but in some other rooms it was badly torn by the streams of water, proving that excellent as are the heat-resisting qualities of materials of this type, they have too little strength to be suitable for fireproofing.

The fire in the rooms on the opposite side of the court was generally much less severe than on the side where our illustrations are taken; but the contents of nearly all were injured to a greater or less extent. The poor qualities of glass as a fire-resisting material, were very well illustrated in Temple Court. The windows opening on the court, the glass partitions between the offices and the central hall, and the ground glass in the doors seem to have been the principal avenues by which the fire spread. A large pane of glass soon cracks when heated, even when quite a distance from the fire, as it tends to expand more rapidly than its framework. The strong draft produced by the flames soon tears down the cracked pane, and through the opening which is left the fire will rapidly pass.

The Temple Court fire was a less severe but a fairer test of the fireproofing materials than was the fire in the Chicago Athletic Club building described in our issue of Dec. 1, 1892. The main lesson to be derived from it is that while total destruction of the contents of rooms and of all wood, plaster and glass will result when a fire is allowed to have free course, the damage to the framework of the building itself, if the fireproofing is properly done, will be practically nothing.

FIRE'S WORK IN A FIREPROOF BUILDING. SUITE OF OFFICES IN THE TEMPLE COURT BUILDING, NEW YORK, AFTER THE FIRE OF APRIL 2.

The rapid-fire gun, invented by Mr. Charles W. Sponsel, of Hartford, Conn., has been very satisfactorily tested at Indian Head. Thirty-five shots per minute were fired; and in the rapid-fire test 5 shots were discharged in 12 seconds. The mechanism is very simple, and owing to the small number of parts its cost of manufacture is claimed to be about 40% less than that of similar guns. It is very effective up to 2,500 yds.

PULLMAN CARS IN ENGLAND.

Three new Pullman cars have recently been added to the equipment of the London, Brighton & South Coast Ry., which has had Pullman car trains and service for several years. The cars were built at the Pullman works in this country, shipped in sections and put together at the railway company's works. They are 60 ft. 8 ins. long over platforms, 54 ft. long over the body, 8 ft. 7 ins. wide over body, and 7 ft. 6 ins. high from floor to top of monitor roof. They are carried on four-wheel trucks, and are said to ride very easily and steadily. The cars, like all the passenger equipment of this road, are fitted with the Westinghouse brake and with an electric communication between the passengers and the conductor and engineman. The exterior is painted a dark brown, with gold tracery. The seating capacity of each is 32 passengers (20 in the saloon and 12 in the smoking compartment), and each is fitted with buffet and lavatories. The saloons are fitted in "vermilion" wood, the smoking compartments, passages, buffets, etc., in mahogany. A special feature of the cars is the arrangement of bay windows. The headlining is of white wood, yellow ground, with gold ornamentations and richly carved "vermilion" wood moldings, large embossed glass deck roof lights and ornamental parcel and hat racks. The swing seats, cane easy chairs, etc., are upholstered in old gold plush, and the windows are draped with crushed strawberry damask curtains. Large mirrors and handsome plate glass divisions separate the smoking rooms from the saloons. There are Wilton carpets on the floors. The cars are lighted by 25 electric lamps in each car, in addition to oil lamps of elegant design for use when running with trains not electrically lighted. Electric bell pushes, to communicate with the car conductor, are placed between alternate chairs or seats, and the cars are warmed by hot water pipes.

A ROOM ON THE SEVENTH FLOOR, OPENING ON THE COURT.

Pullman cars are in use on several English railways, and those of the London & Southwestern Ry. and the London, Brighton & South Coast Ry. were described in our issues of March 21 and April 18, 1891. An article on English saloon cars was published in our issue of March 23, 1893.

Newark, N. J., wants to annex about one-half of Essex County by uniting under one municipal government the Oranges, Bloomfield, Montclair, Harrison, Kearny and Belleville. Newark claims that only 15 cities in the United States surpass her in population, and that the consolidation proposed would be in accord with the tendency of the times, as shown in Chicago, Boston and New York, and that it would be a beneficial arrangement to all concerned.

LOCOMOTIVE BOILER CONSTRUCTION.

In our report of the last meeting of the New York Railroad Club, in our issue of March 23, we gave an abstract of a paper on the above topic by Mr. W. T. Dixon, Chief Draftsman of the Rogers Locomotive works. The following statement of some of the principal difficulties encountered with the Belpaire boiler was not given in that abstract:

When properly designed and well constructed the Belpaire boiler probably presents the best solution of the problem of crown staying yet brought forward. The crown-sheet is comparatively unobstructed, and may readily be kept clear of sediment. The staying is positive, all the stays having good bearings in and on the sheets. All the strains may be accurately calculated and provided for, and all the stays may, if desired, be made of one length—an advantage that is appreciable.

The two main objections that have been raised against it are the difficulty of keeping the crown-stays tight in the neighborhood of the ends of the braces running from the back head to the top of the firebox shell, owing to the constant downward pull of these braces. This trouble may be overcome in several ways: (1) By dispensing with the round back-head braces, and substituting in their places gussets or plate-braces attached to the roof-sheet by long angle-irons, thus distributing the strain over a large area and preventing its localization; (2) by running the braces forward to the waist of the boiler—a plan which is in many cases impossible owing to their number; (3) by running the braces clear forward, and attaching them to the front flue-sheet—a plan I would not recommend owing to the difficulty in keeping the ends tight, the incessant vibration tending to cause leaks; (4) by riveting heavy angle-irons crosswise of the roof-sheet as close as possible to where the brace ends take hold, thereby stiffening the sheet and preventing its "giving."

The second objection to this type of boiler is the difficulty experienced in some quarters of keeping the top corners of the throat of the Belpaire sheet tight where they join the shell. These corners have been a thorn in the side of the mechanical department of more than one road. The trouble in the majority of cases appears to be caused by not allowing the flue-sheet sufficient room in which to expand vertically. After a boiler is fired up, the firebox, being at a higher temperature than the shell surrounding it, expands more than the shell. The two are rigidly connected together at the bottom by the mud-ring, so that the only direction in which the firebox sheets can expand is upward, the result being that the crown-sheet is slightly higher above the center line of the boiler when it is hot than when it is cold. As the flue-sheet is more rigid in an up and down direction, owing to its flat shape, than the side sheets, which are more or less arched or curved, it seems plausible to suppose that a greater strain is brought to bear on the crown-stays in closest proximity to it than on those further back.

If the first row of crown-stays is closed to the flange uniting the flue and crown sheets, say 1½ or 2 ins. from the edge of the flange to the center of the stays, the crown is hardly able to give at all, and the stays are carried up the amount the flue-sheet expands. This, of course, tends to distort the top of the shell at a point close to where it is riveted to the waist of the boiler. The constant moving up and down which takes place every time the boiler is cooled off, and, indeed, whenever the fire-door is opened, permitting a current of cold air to strike the flue-sheet, causes the seam to work or loosen, and allow more or less serious leakage to occur. If, however, the first row of crown-stays is kept well back from the flue-sheet, say 5 ins., from the edge of the flange to the center of the stays, the intervening portion of the crown, while amply strong to withstand the steam pressure, has a chance to bend or give slightly, with the result that the upward thrust on the stays and the consequent distortion of the shell is lessened. If, in addition to throwing the centers of the stays back, a heavy bar-iron brace running crosswise of the shell-top and well down the sides is riveted on just back of the throat or Belpaire sheet seam, the trouble with leaky top corners can be reduced to practically nothing. There is another advantage in throwing the first row of crown-stays back from the flue-sheet as far as is consistent with absolute safety, which is that the expansion strains in the flue-sheet itself are lessened, and the chance of cracking the sheet between the flue holes is reduced. On some of the English roads I saw radial boilers in which the first two rows of crown-stays did not go through the top of the sheet at all, but were connected to wrought iron or possibly cast steel cross-heads, which were in turn pinned to a piece of T-iron riveted to the shell. This arrangement apparently worked well and gave satisfaction, but has the disadvantage of being pretty expensive.

The discussion on this paper is abstracted as follows:

Mr. H. L. Leach.—Two important points in boiler design are to secure good circulation and to avoid internal

strains due to expansion and contraction from uneven heating. The question was recently asked: "What proportion of boiler explosions occur immediately after the boiler has been overhauled and repaired?" It must be admitted that one frequently sees the statement in reports of locomotive boiler explosions that the engine had recently been repaired. In boilers constructed a number of years ago the outer crown sheet was joined to the side sheets by a lap seam which was about at the level of the inner crown sheet. The side sheets were held rigid by the stay-bolts, and the outer crown sheet was held by the sling-stays, but for a short space on either side of this seam there were no stays. Thus expansion and contraction would cause the plate to bulge in and out at this seam, and grooving was the natural result. But the location of the seam made it difficult to examine its condition on the inside unless the firebox was taken entirely out. When such a boiler was cleaned, and new stay bolts and sling-stays were put in, the expansion and contraction would be apt to be concentrated at this seam more than before, owing to the stiffness of the new stays, and soon the seam would give way and there would be another boiler explosion on record.

I was once in a repair shop, some 30 years ago, where the master mechanic showed me an old engine that was having general repairs. There was a lap seam along the side, and a man was at work drilling some ⅝-in. holes a couple of inches from the edge of the lap. I asked what that man was doing there. He replied, "We found when we took the jacket off that there was a little bit of a weep through there, and probably it is pitted a little on the inside." I said, "It looks to me as though it was along on the line of the lap on the inside of the boiler, and that there is a furrow along there that is dangerous." "Oh, no," he said, "that boiler has stood 120 lbs. of steam right along. That boiler is all right." I noticed about four weeks afterward that there had been an explosion on a certain road, and I went to examine it, and I found that that plate had gone over to the other side. Now there was a crack along on the edge there that was dangerous that had not been examined on the inside. The flues had not been taken out, and the master mechanic was so careless that he had let it go, thinking perhaps it was only pitted.

Mr. A. E. Mitchell: Mr. Dixon's paper did not mention the necessity of having all stay-bolts drilled from the outside at least ¼ in., so as to act as a tell-tale in case of breakage. I am also greatly in favor of a double-riveted mud-ring, especially on boilers having the firebox on top of the frames. Single-riveted mud-rings require frequent calking of the lower seams, which is a difficult matter, and the double-riveted mud-ring guards against such failures and stiffens the boilers. Concerning Belpaire boilers, I have often wondered why the top row of stays on the side sheets should fail as they do. It has been suggested that it is on account of the difference in expansion of the side-stays and cross-stays, which run across the boiler over the firebox, from side sheet to side sheet. Suppose the side-stays are 6 ins. long and the cross-stay 50 ins. long. Then, with a given heating the cross-stay will elongate much more than the side-stay, and will throw an undue amount of work upon the side-stay. We are running our engines on anthracite and bituminous coal as it happens, without any change of grates or draft appliances. Many of these engines run westward on hard coal and come east on soft coal.

Mr. Colvin: I have known locomotives to have 35 or 40 stay-bolts broken next to the mud-ring, and not one broken in the upper rows. I have never been thoroughly convinced that the difference in expansion of the inner and outer sheets was the real cause of the breakage of stay-bolts. I have seen the side sheets of iron fireboxes crack with an opening ⅛ in. wide, and if the sheet was expanding, why should the crack form and open so wide? Recent experience seems to show that staybolts are as likely to break near the flue-sheet and around the door as in the upper rows.

The discussion here turned to the question of the advantages of sling-stays in a crown-bar boiler. The experience of Mr. Eddy, of the Boston & Albany, was alluded to. He built several crown-bar boilers without sling-stays. His experiments showed that when a boiler was under steam the crown sheet was 5-16 in. higher than when the boiler was cold. Quite a number of these boilers without sling-stays dropped their crown-sheets, but only one of them ever exploded.

Mr. Angus Sinclair said that while the Belpaire boilers seemed to be an ideal structure on paper, in practice it was found to give serious trouble, and to be an expensive boiler to keep in repair. The throat sheet is nearly always leaking, and this is a sign of weakness at this point. It is the fashion nowadays to abuse the wagon-top boiler, but the record of boiler explosions shows that very few boilers of this class give way and cause destruction. The fact is often overlooked that with the wagon-top boiler much better circulation can be secured, and there is more steam room, thus securing drier steam.

Mr. Chas. Stryker said that he had thought of putting a wagon-top on the Wootten boiler. A straight Wootten boiler has very little steam room, and to make the most of what there is, very shallow water is carried on the crown sheet. An engine standing on a 3% grade with 2¾ ins. of water on the crown sheet will have the front ends of the flues barely covered by the water. It is a common complaint of runners that they cannot make time on account of wet steam. The wagon-top might be applied to the Belpaire boiler, but there would be apt to be trouble with the flanging, for the sheet would have to be thinned at two points. There would be trouble from leakage, and the sheet would have a short life.

In applying the wagon-top to a Wootten boiler Mr. Stryker would do away with the combustion chamber, as it is a nuisance. Behind the brick arch the cinders accumulate to the depth of a foot or more, and stop the draft in the flues. Besides that, where there is a leaky flue or anything of the sort, corrosion will begin, as there is no chance for drainage. The sheets are eaten through in a short time. The principal objection to any combustion chamber running far into the shell, however, is that it is secured with stay-bolts connected to the shell sheets. There is scarcely any circulation here, and sediment collects rapidly. These are the stay-bolts that give most trouble. Lumps of scale a foot long have been taken out of boilers at this point with a pick and bar. Plainly, this is a source of danger.

The advantages on the side of safety of increasing the depth of water on the crown sheet are very great. Low water is the most frequent cause of locomotive boiler explosions.

Mr. M. N. Forney said that the best way to cure the multiplicity of troubles with stay-bolts might be to do away with stayed surfaces altogether. Experiments have been made in Hungary, Russia and Germany looking to the abandonment of the firebox end of the boiler, and making a fire-box lined with firebrick, delivering the heated gases to a plain cylindrical tubular boiler. Such fireboxes are now in use on the Cromwell line of steamers, and on one vessel in the U. S. Navy. A very large number of portable boilers of the locomotive type have been built on this plan, and a test is soon to be made of this system of construction on a prominent railway in this country.

SPECIFICATIONS FOR BRICK PAVING.

In our issue of March 30 we gave some particulars of tests of paving brick, and we give below an abstract of the specifications for brick paving at Knoxville, Tenn., for which we are indebted to Mr. Nicholson, City Engineer:

The roadway will be excavated to a depth and form sufficient to bring it, when thoroughly compacted, 11½ ins. below and parallel to the prescribed form of the completed pavement. The whole surface will then be thoroughly rolled with a five-ton roller, but the contractor may, at his own risk, use a heavier roller. Any part that cannot be reached by the roller must be thoroughly tamped with tampers not less than 6 ins. nor more than 10 ins. square at the bottom, nor less in weight than 30 or 90 lbs., respectively.

When soft or spongy material is encountered, which, in the opinion of the engineer or inspector, is not sufficiently compact after rolling, it must be excavated and refilled with sand, gravel, clean clay, or other suitable material, and rolled, or tamped if not accessible with the roller, in layers not exceeding 4 ins. in thickness. When filling is necessary to bring the roadway to the proper grade, it must be done with clean gravel, clay or sand, in layers not exceeding 4 ins. in thickness, each layer being thoroughly rolled or tamped.

The contractor will remove the old curbstones, and excavate a trench 18 ins. wide on the new line of the curb, with the bottom parallel to and from 20 to 28 ins. below. The bottom of this trench must be thoroughly compacted by tamping. In the bottom of this trench and 6 ins. below it on the side next to the property line, there must be laid a line of 3-in. tile pipe, the trench for which must be cut true and even, so that the tile will lie on a grade parallel to the curb grade and 26 to 34 ins. below it. After the tile is laid, the ditch must be filled with clean cinder or gravel to the depth of the bottom of the curb ditch.

On the roadbed there will be placed a 6-in. layer, and in the bottom of the curb trench a 4-in. layer of concrete, composed of broken stone, hydraulic cement and sand. Whenever water or gas pipes have been newly laid, an extra layer of concrete 6 ins. thick must be laid over the ditches in which said pipes are laid. The sand must be clean and sharp, free from loam or dirt, and must be kept on a tight platform of boards, and screened, when ordered.

The cement must be good hydraulic cement, which will not leave a residue of more than 10% by bulk on a screen of 2,500 meshes to the square inch, and which will show a tensile strength of 60 lbs. per sq. in. after being made into a briquette of neat cement, with least possible amount of water, at a temperature between 60° F. and 70° F., then exposed to the air one hour, then immersed in water of the above temperature for 23 hours. The stone must be clean broken limestone whose largest dimensions must not be more than 2½ ins. The stone must be free from dust and dirt, and thoroughly drenched in the pile, care being taken, however, to allow all free water to escape from the pile before using.

The concrete will be prepared as follows: In a tight box of boards, one part, by measure, of cement, and two parts, by measure, of sand, shall be thoroughly mixed dry. Then the mixture will be placed on a platform or box and mixed with the least possible amount of water, added to the cement and sand by pouring from a sprinkler, or from a spray nozzle. Then add four to five parts broken stone and mix thoroughly. This concrete will then be spread upon the roadbed, and tamped until free mortar flushes on the surface. This tamping to be done so as to bring the surface of the concrete parallel to, and 5½ ins. below, the finished surface of the pavement; this must then be flushed over with a thin grout made in the same proportions and of the same material as the concrete mortar. This concrete is to extend across the bottom of the curb ditch 4 ins. thick. As fast as the concrete is completed it must be protected by a covering of sand, and allowed at least 48 hours to set before laying brick upon it.

The curbstones will next be blocked into position, and have concrete tamped under and around them to the height of the top of the roadway concrete in front, and the height of the finished pavement at back. Upon the concrete foundation thus prepared will be spread a cushion layer of sand 1½ ins. thick, which must be struck off perfectly smooth, parallel to, and 4 ins. below the required finished surface of the street.

The bricks or blocks to be used for paving shall be straight and smooth, free from checks or fire cracks, and thoroughly burned throughout. The corners shall be rounded to a radius of ¼ in., or beveled to ¼ in. on each face. In size, they shall not vary more than 2% in any dimension from the standard adopted for the kind of bricks or blocks to be used. When broken, the fracture shall be smooth and straight, and the texture uniform throughout. The amount of moisture absorbed when the whole brick or block, or pieces of same have been immersed for 72 consecutive hours in water, shall not exceed 2% of the weight of the sample free from moisture in air. No bricks will be accepted which contain lime or other soluble substances in sufficient quantities to cause spalling or pitting of the surface when soaked in water, for three consecutive days, and then exposed to the air for a corresponding length of time. Tests for brick shall be made before the contract is let, with samples to be furnished by bidders.

The average crushing strength of 2-in. cubes taken from any part of the brick shall not be less than 12,000 lbs. per sq. in. The specific gravity shall not be less than 2.1 by the formula:

$$S = \frac{W}{W' - W''}$$

Where S = specific gravity; W = weight of specimen, freed from lime, in air; W' = weight of same after 72 hours' soaking; W'' = weight of same in water.

In the test for determining the resistance to abrasion or impact—that is, the rattler test, the loss of the brick shall not exceed 2¼ times that of Lithonia Georgia granite, when subjected to a like test. A cylinder used at foundries for cleaning castings is used, containing pieces of cast iron weighing from one to three pounds, and in the condition in which it is ordinarily used for cleaning castings. The bricks shall be carefully weighed and placed in the rattler, which is revolved at the speed of 24 revolutions per minute, and at the end of 1,000 revolutions the rattler will be stopped, the samples taken out and weighed accurately, and loss noted. A number of billets of wood will be placed in the cylinder to prevent breaking. The second, third and fourth tests shall be in the same manner as the first, except that the wooden billets will be left out of the rattler.

Upon the layer of sand the bricks will be laid on edge in straight rows at right angles to the line of curb, except at intersections where they shall be laid at an angle of 45° to line of curbs with their tops even. The brick in each row must break joints not less than 3 ins. with those of the adjoining rows; none but whole brick will be used, except in making closures at the curb or starting row. When street car tracks exist upon the street, the brick must be laid close against the rail, and flush with it when settled into place by rolling or ramming. In laying the bricks, care must be taken to keep the rows straight and close together, and in making closures they must be well wedged together, and the closures fitted tight into place.

After the bricks are laid they shall be evenly settled to a firm bearing in the sand, by rolling with a roller weighing not less than one ton per lineal foot of space, or by ramming on a wooden piece not over 8 ins. wide, by 16 ins. long and 2 ins. thick, struck with a hammer weighing not less than 30 lbs. No ramming or rolling

to be done on the brick nearer than 20 ft. to the last row of brick laid. After ramming or rolling any broken or badly spalled brick must be at once removed and replaced by good, whole brick; also any which are too high or too low must be raised or lowered to the proper surface.

After the ramming is completed and the surface cleaned of loose material, all interstices shall be thoroughly filled with No. 6 paving pitch (made from a direct distillation of coal tar without other admixtures) heated to about 300° F., and poured into the joints while smoking hot; care being taken to pour it directly into the joints, and not to slush it over the surface. After the first pouring has been allowed to cool, a second pouring or plugging shall follow it to fill full any interstices which may not be filled to the surface. This plugging must be done with especial care along the line of the gutter, and next to the rails of the street car tracks, to insure a perfectly water-tight surface.

When the filling of the interstices is completed the whole surface of the roadway will be covered with a uniform coat ⅛ in. thick of No. 6 paving pitch, poured on while hot and immediately covered with clean, coarse, sharp dry sand, about ¼ in. deep.

THE HAMILTON & BARTON INCLINE RAILWAY.

The steep-grade inclined cable railway at Bristol, England, was described in our issue of March 30, when other English incline railways on the same system—that is, operated by a water balance for the upper car—were also referred to. In this country most of the steep-grade cable lines are used for teams and vehicles, as well as for passengers, and are operated by heavy cable winding machinery. A railway of this latter class was opened at Hamilton, Ont., June 11, 1892, and we take the following particulars of the line from a paper read by Mr. J. W. Tyrrell, of Hamilton, before the Association of Ontario Land Surveyors in February, 1892:

Along the south side of the city, and extending for miles in either direction, stretches a bold, steep escarpment, commonly called the Hamilton Mountain. The city is built on what has been the beach of Lake Ontario—a strip of land about two miles wide—while the elevation of all the back country is from 200 ft. to 400 ft. higher. This high table-land, which has been cut away in part by the action of the lake, is a very serious barrier to traffic, and though a number of roads have been constructed, and some of them in use for a great many years, leading up the mountain, their grades are so steep—varying from 10 to 15%—that ordinary loads cannot be taken up with one team of horses, and light vehicles only with difficulty. The natural result of this inaccessibility of the table-land from the city has been that though the most valuable resident property in Hamilton lies at the foot of this escarpment, the property on top, only a few hundred feet distant, is valued at little more than farmland and is very little built upon.

In 1890 the Hamilton & Barton Incline Ry. Co. was organized, and the greater part of the right of way was secured from the township of Barton over an original side-road allowance. Mr. M. D. Burke, who had built several inclined railways in the United States, was engaged, visited the ground and prepared the general plans for the road; but not being able to remain in the country, the writer was employed to take charge of the construction. His proposition was to construct a straight cable road of uniform grade from a point at the commencement of the rapidly rising ground to the top of the escarpment.

The distance between these two points along the line of location was found to be about 700 ft., and the rise 190 ft. Of this rise 125 ft. occur within the southerly 200 ft.—that is, nearest the face of the hill; consequently, it was found that by adopting a uniform grade the central portion of the track would be at an elevation of about 50 ft. above the surface of the ground. The design of the company being to provide for the carriage of heavy loads of coal, electric cars, etc., as well as passengers, it was considered advisable that the road should be built in a substantial manner, and it was decided to adopt stone and steel as far as possible.

The road is a double track inclined railway. The lower portion of the roadbed is built upon the ground, partly through a cutting and partly upon an embankment formed by the material taken from the cut. The roadbed at the lower end commences in a pit 13 ft. deep—that is, 13 ft. below the level of the approach to the track. This pit is formed to receive the cars, which are built with level platforms, and consequently, to suit the steep grade, which is 30.7%, require to be 13 ft. high at the one end, the other being as close to the track as possible.

The cutting, which commences with a depth of 13 ft., as mentioned, within a very short distance attains a depth of 30 ft. The width of roadbed being 34 ft., the amount of material requiring to be excavated was therefore very considerable; and as much of this as could be used with economy was graded up to form an embankment. However, on account of the character of the material passing from a stiff clay near the surface to a soft, red rock at the bottom, and the heavy grade of the road, this work was very expensive.

The company having only acquired the right to occupy 48 ft. of the side-road, it was necessary to build retaining walls, both to support the sides of the cutting and those of the embankment, which reaches a height of 25 ft.

The upper end of the embankment is terminated by a heavy stone abutment, built to receive the lower ends of four girders forming part of a steel trestle viaduct. This abutment is built with large, heavy stone, and provided with wing walls. Some difficulty was experienced in obtaining a good foundation for this stonework, as the ground to a depth of about 20 ft. was found to be loose-made earth, consisting of old boots, ashes, etc. A ravine had crossed at this place, but for years an untiring old squatter had been at work improving this scrap of a road allowance, only to have it taken from him when his task was about completed. In addition to the fact of the ground being loose, a large brick sewer cut through the foundation. This, however, was stepped over with large, flat stones, care being taken to leave plenty of room over the sewer to allow for settlement; and the former difficulty was overcome by excavating until a hard, stiff clay bottom was obtained. These difficulties were met with again at other points higher up the bank in obtaining foundations for piers to support the steel trestle, which extends over about two-thirds of the length of the railway.

The viaduct, briefly, consists of eleven spans of 30 ft., and one of 37 ft. Most of the bents, which are of steel, supported by two stone piers or pedestals, are from 30 to 50 ft. in height. They carry four parallel track girders 2 ft. in depth and spaced 8 ft. c. to c. The whole structure is designed so that a moving load of 60,000 lbs. will not produce a greater strain than 10,000 lbs. per sq. in. on any member. Across each pair of these inclined girders the ties are placed, and upon them, directly over the center of the girders, the track rails, which are bolted to the girders. There are then two parallel tracks, 8 ft. c. to c., of rails and 8 ft. apart. Upon the bank below the trestle the tracks are laid in the ordinary way, except that the ties are supported on the lower side by stout stakes to prevent them from working down hill; and the grade of the whole is 30.7%.

On either track runs a single car 36 ft. in length by 14 ft. in breadth. The cars are constructed with level

Hamilton & Barton Incline Railway; Hamilton, Ont.

platforms, being supported by wedge-shaped frameworks, which raise the platforms toward the lower end about 13 ft. above the tracks. The cars are combination affairs, being arranged to carry passengers and teams at the same time. A width of about 5 ft. along one side of each car is covered in to form an apartment, the inside of which resembles the interior of a street car, while the remaining 9 ft. space is open, being inclosed only by iron lattice walls on the sides and iron folding gates at the ends, which are opened alternately at top and bottom of the plane to admit of the entrance and exit of teams. Attached to two heavy timbers, braced by heavy iron knees, in the lower framework of each car, are two 1¼-in. steel wire cables, each having a tensile strength of 125,000 lbs. by actual test. From the cars the cables are carried up the center of the tracks on small carrier wheels 14 ins. in diameter. To prevent noise and wear of the cables these are made so that they can be packed with leather or rubber. The cables are attached to the cars in such a way that they can be easily slackened or tightened to make allowance for variation of temperature or stretching of the cables.

At the head of the plane the cables pass over large cast iron sheave wheels, 10 ft. diameter, strongly supported by iron girders and columns. Thence the main cable passes down to a winding drum, 10 ft. diameter, about 30 ft. below, situated in the basement of the station at the head of the plane; but the safety cable passes from the sheave wheels onto another large cast iron wheel of about equal size, which is set in heavy iron framework and securely anchored to the solid rock, so that in case of the possibility of an accident happening to the draft cable the cars would be held securely by the safety cable. Powerful brakes are attached at either side of the drum and to the safety wheel, and these may be applied by the engineer from the pilot house. The foundations of the drum, which weigh about ten tons, are strongly anchored to the solid rock by 16 iron bolts, 2 ins. diameter. The drum is operated by a pair of Wheelock engines of about 125 I. HP.

The station situated at the head of the plane, and which contains all the machinery, is a four-story stone and brick building. The basement is occupied by the engines and drum, the boilers and fuel room, and also a large room to be used as a workshop. The second and third floors are designed to be used as a dwelling for the engineman and his family, and the upper floor, which is only on a level with the top of the hill, contains the driving platform, a waiting-room, a boardroom, and a large covered balcony looking out over the city. In the center of the driving platform, and opposite the center of the tracks, is situated the 4×8-ft. pilot house. This is built with large glass windows on all sides, and commands a view of the whole road. Within it stands the engineman who has within arm's reach the means of controlling every part of the machinery.

At the lower end of the plane there is another small but neat station, with a brick dwelling above it for a caretaker. The entrance to this is guarded by sliding gates, which are opened when a car is down. Into the face of the car pit are built four large iron air buffers—two for each car to strike against. These consist simply of 18-in. iron cylinders provided with pistons which are drawn out by wire sash-cords hung with weights and working over pulleys.

A NATURAL PORTLAND CEMENT.

A correspondent of "The Times," of London, has reported a discovery of natural Portland cement in Tasmania which, if true, is certainly a very important discovery.

A discovery of great commercial importance to the Australasian colonies has been made on Maria Island, a dependency of Tasmania, consisting of a practically inexhaustible deposit of carboniferous limestone which, upon being treated, yields in itself, and without any admixture, a Portland cement of very high quality. The certificates of many colonial experts who have tested this cement leave no doubt whatever as to its valuable character and properties. Mr. Henry Faija, M. Inst. C. E., has just completed an experiment with this peculiar material at the Rugby and Newbold cement works. Two tons of raw material were treated by the dry process used at Rugby with highly satisfactory results. The analysis shows this material to be a normal uncalcined cement, and that when calcined it bears favorable comparison with the best English cement. The cement made from this raw material was submitted hot from the mill to very severe tests by Mr. Faija, and did not show any indication of contraction or expansion. It has a slightly greenish tinge. It is heavy, weighing 113 lbs. per bushel, and having a specific gravity of 3.152. It is of a slow-setting character, and after lengthy immersion in water attains the hardness of basaltic rock.

The average tensile strength attained by Mr. Faija was as follows: Neat cement—Average, 463 lbs. per sq. in. from five briquettes seven days old; average, 536 lbs. per sq. in. from five briquettes 14 days old; average, 646 lbs. per sq. in. from five briquettes 28 days old. Sand tests—One part of cement and three parts of sand. Average, 150 lbs. per sq. in. from five briquettes 7 days old; average 258 lbs. per sq. in. from five briquettes 28 days old. Tests made at the Rugby and Newbold cement works from this cement, after three weeks' exposure to the air, gave an average tensile strength of 629 lbs. per sq. in. from briquettes 7 days old. This cement was also tested by the Patent Adam Stone Co., at the Greenwich works under powerful hydraulic presses. With one part of cement and three parts of granite they produced a stone certainly superior to any made with English cement. Samples tried with neat cement produced specimens so extremely hard that, by the usual process of stoning, a high polish was given to them, and this they could not obtain with English cements. From the accounts of geologists and other experts who have visited Maria Island, the deposits of this material appear to be inexhaustible, and there is every reason to believe that the establishment of cement works in Tasmania to deal with these deposits will prove a great benefit to that and the neighboring colonies, as these works should produce all the large quantities of cement hitherto imported from Germany and England for public and private works, and produce it, moreover, at a lower cost.

THE WEATHER OF 1892.

The Monthly Weather Review, published by the chief of the Weather Bureau, at Washington, D. C., contains in its December issue an annual summary of the weather in the United States for 1892. The points of greatest general interest may be noted as follows:

The highest temperature registered at any regular station was 116°, at Yuma, Ariz., on June 20; and the lowest was 45°, at Miles City, Mont., on Jan. 18. The annual mean temperature was highest in the lower Colorado and lower Gila valleys, and at Key West, Fla., where it was above 75°.

The annual mean was lowest on the north shore of Lake Superior; in the Saskatchewan Valley and at mountain stations in Central Colorado, where it was below 35°.

The greatest precipitation for the year was 109.67 ins., at Neah Bay, Wash. The yearly precipitation exceeded 70 ins. along the Washington coast, on the California coast, south of Eureka, at stations on the Central Pacific Railway, over the Sierra Nevada Mountains, in an area in Southwestern Arkansas, and at Mobile, Ala. In Novia Scotia, at points on the Florida South Atlantic coasts, generally on the Middle Gulf states, northeastern Texas, Arkansas and Tennessee, in areas in northern California and along the Oregon and Washington coasts the yearly amount exceeded 50 ins. Over the greater part of the remaining area the annual precipitation ranged from 30 to 50 ins. The least precipitation for the year was 5 ins., at stations in the Colorado Desert and lower Colorado Valley. Less than 10 ins. were reported generally over the middle and southeastern plateau regions and in southeastern California. The yearly amount was less than 20 ins. on the northeast slope of the Rocky Mountains, and from the Rocky to the Sierra Nevada ranges.

The official report gives the annual summary for 1892 for the individual stations in the several states and territories, and also presents charts showing the annual mean pressure and prevailing winds, and maximum and minimum temperatures and precipitations.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

EBENSBURG & BLACK LICK.—The contractor, Chas. Macfadden, will have about 800 men at work on this Pennsylvania railway during this month. The road will be 36 miles long and will run from the Cambria & Clearfield R. R. to Black Lick Station, in Indiana Co.

NEW YORK, PENNSYLVANIA & OHIO.—Ohio papers state that this company proposes to extend its line into Cincinnati, O. It is stated that the company has purchased the stock of the old tunnel through Walnut Hill and will complete the work. This unfinished tunnel was commenced about 30 years ago, but the undertaking then was found to be too expensive. The tunnel, if finished, would be nearly 1¼ miles in length, but only three-quarters of a mile is finished. The part now finished cost the old company something over $800,000.

BUFFALO, ROCHESTER & PITTSBURG.—The line from Clearfield to Jefferson Line, 27 miles, is approaching completion, and if everything goes well will be in operation by May 1. The work has been very heavy, there being a large amount of rockwork. There was also a steel viaduct at Curwensville, Pa., 775 ft. long and 65 ft. high.

OSCAWANA & CORNELL.—Work on the construction of this road, running from a connection with the New York Central & Hudson River R. R. to the site of the Cornell Dam, began April 3. Marshall & Force, Contrs., Jas. S. Haring, Ch. Engr., Oscawana, N. Y.

PITTSBURG & LAKE ERIE.—Surveys are reported in progress for a line from Owensdale, Pa., through the property of the Pine Tree Land Co., known as the Pine Tree Extension.

Projects and Surveys.

MONROE & TOLEDO.—The directors of this company, whose incorporation was noted last week, are: Wm. H. Baldwin, Jr., Henry C. Potter, Jr., S. T. Crapo and Edwin Saunders, of Saginaw, Mich., and Wilson H. Tousey, of Bay City, Mich.

MONTFORD COLONIZATION.—Bids are being received for grading 13 miles of this railway from Lachute to St. Sauveur, P. Q., 21 miles. Secy., E. D. Porcheron, Montreal, P. Q.

INDIANAPOLIS, BLOOMINGTON & BEDFORD.—Gen. Man. Benj. Thompson, Bloomington, Ind., writes us that the preliminary survey for this railway has been completed and the estimates are now being prepared. It is hoped to be able to let contracts in July or August. The line will be 80 miles long and will run from Indianapolis, Ind., via Martinsville and Bloomington, to Bedford, Ind. There will be some heavy work; maximum grade 1½% and maximum curve 6°. Pres., Newell Sanders, Chattanooga, Tenn.

HUDSON RIVER TRACTION CO.—Chartered in New York to construct and equip railroads and carry out other works of improvement, in the counties of Westchester, Putnam, Dutchess, Columbia, Rensselaer and elsewhere; capital, $5,000; directors, E. M. Davison, J. M. Wainwright, A. J. F. Van Deventer and G. H. Rose, of New York city, and John W. Graynor, of Morris Park, N. Y.

Southern.—Existing Roads.

FLORIDA CENTRAL & PENINSULAR.—About 1,800 men are now at work on the line from Hart's Road, Fla., to Savannah, Ga., 114 miles, and 47 miles have been graded. It is expected that trackiaying will begin soon.

WELCH'S MILL & CENTERVILLE.—Surveys are being made for an extension of this narrow gage railway. J. E. Bozeman, Centerville, Ala.

CHESAPEAKE & OHIO.—This company has engineers surveying for a branch line up Guyandotte River. The line upon which they are at work leaves the main line at Barboursville, and follows the east side of the river for some miles. Several surveys over practically the same route have been made in the past, but this is the first one that has been made by the railroad. The territory through which the line passes is a fine and at present undeveloped coal and timber country.

Projects and Surveys.

MISSISSIPPI.—A railway company has been organized at Jackson, Miss., for the purpose of building a road to connect with the Yazoo & Mississippi Valley R. R. Mr. Frank Heer was elected pres.; Dr. G. H. Jones, vice-pres.; C. D. Smith, treas.; Dr P. H. Jones, secy.; Dr. E. C. McKowen and Hon. I. W. Wall, directors. Capital stock, $30,000. About $15,000 has already been subscribed.

MAPLEWOOD IMPROVEMENT CO.—This company will build a 4½-mile railway. Headquarters at Maplewood, Tenn.

CALDWELL LAND & LUMBER CO.—This company proposes to build a railway 30 miles long from Lenoir, N. C., to its timber lands.

MANCHESTER & AUGUSTA.—Preparations are being made to extend this railway to Denmark, S. C. The company is now securing right of way, and if this can be done without too heavy an expense work will begin at once, with the intention of completing the extension by next winter. There will be 25,000 ft. of trestle on the 45 miles, about half of which will be temporary. There will be an iron bridge over the Santee River 600 ft. long, and two other iron bridges of 100-ft. span each.

Northwest.—Existing Roads.

DULUTH, MESABI & NORTHERN.—The contract for building the 18-mile branch to the Lake Superior mine has been let to Wolf & King, of Duluth, Minn. A force of about 800 men is now at work on the extension into Duluth, Minn.

Projects and Surveys.

DULUTH, RED LAKE FALLS & NORTHERN.—According to the Duluth, Minn., "Herald," J. B. Holmes, of Minneapolis, Minn., Pres., states that he has secured financial backing in the east for building this road, which is projected to run from Duluth, Minn., to St. Thomas, N. D., 340 miles. A meeting of the stockholders was held in Duluth, April 14, to make some changes in the articles of incorporation, so as to allow the line to run through the Mesabi iron range. The road is to be bonded for construction purposes to the extent of $25,000 per mile for 100 miles of the main line, and provision is made for bonding branch lines for $20,000 per mile. It is also provided that special bonds shall be issued to the extent of $500,000 for terminals in the city of Duluth. These terminals are to be on Minnesota Point. Grading was begun at Duluth, April 1, in order to comply with the provisions of the franchise granting right of way over certain streets, and it is expected to begin active construction about May 1.

SPRINGFIELD CONSOLIDATED RY. CO.—This company has been chartered in Illinois with a capital stock of $750,000. Incorporators: C. K. Minary, Frank H. Jones, and Bluford Wilson.

BOONE VALLEY COAL & RY. CO.—This company has been chartered in Iowa for the purpose of acquiring coal lands and building railways.

CHARLES CITY & NORTHEASTERN.—This railway company has been chartered in Iowa, with a capital stock of $500,000.

Southwest.—Existing Roads.

NATCHITOCHES.—There is talk of extending this railway from Grand Ecore to Shreveport, La. Pres., L. Caspari, Natchitoches, La.

TEXARKANA & SHREVEPORT.—Surveys are reported in progress for an extension from Lynn, Ark., south. Gen. Man., B. Collins, Texarkana, Tex.

TEXAS, LOUISIANA & EASTERN.—S. A. Walker, Treas., St. Joseph, Mo., is reported as saying that the eastern terminus of this railway will be at Baton Rouge, La. The road begins at Conroe, Tex., and about 27 miles have been completed and 15 miles more graded. Enough rails to lay 35 miles of track have been purchased. It is intended to build a spur north to Cold Springs, Tex., to open up stone quarries. The main line penetrates a fine timber country.

TEXAS CENTRAL.—The stockholders have voted in favor of an issue of bonds to build extensions and make other improvements. The extensions lately spoken of are from Dublin to Thurber, Tex., 32 miles; Roberts to Greenville, Tex., 18 miles; Ross to Waco, Tex., 10 miles; and Albany to Anson, 40 miles. The surveys for the line to Thurber are now in progress.

MISSOURI PACIFIC.—The local papers assert this company's intention to build a line from Nevada to Bagnell, Mo.

CENTRAL RY. & TERMINAL CO. OF ST. JOSEPH.—This company has been chartered in Missouri. The object stated is the construction of a standard gage railway from Pattonsburg, in Daviess Co., Mo., to St. Joseph and thence to Sibley's bridge, on the Missouri River, in Ray Co., a distance of 120 miles. The road will pass through Buchanan, Daviess, Platte, Gentry, Andrew, De Kalb, Clay, Clinton and Ray counties. The directors and stockholders are: R. T. Davis, John Townsend, Daniel McDonald, F. J. Smith, S. H. Sommers, Fred Enderbrock, William Rush, J. L. Bittinger, N. J. Riley, J. F. Tyler, J. W. Boyd, W. B. Johnson and I. W. Brockett, all of St. Joseph, Mo.

WEATHERSFORD, MINERAL WELLS & NORTHWESTERN.—It is stated that an examination of the country is being made, looking toward the construction of an extension from Mineral Wells, Tex., northwest.

PAN AMERICAN.—W. H. Baker, Ch. Engr., aided by a corps of assistants, is making a survey of the proposed line through Texas. The road will start at Victoria, Tex., where connection will be made with the Southern Pacific R. R., and will follow the Gulf Coast to Brownsville, thence along the coast to a point below Tuxpan, Mex., where the detour will be made, and the line built to the City of Mexico. The work of constructing this road was begun at Corpus Christi two years ago. The contract will soon be let for the building of the road from Victoria to Refugio, Tex.

Projects and Surveys.

GALVESTON, SOUR LAKE & EASTERN.—This company has been organized by J. E. Newton, of Houston, Tex., to build a railway about nine miles long from Sour Lake Station to the health resort at the lake of which he is proprietor. W. A. Polk, Ch. Engr., Houston, Tex.

WACO, MOOREVILLE & AUSTIN.—It is stated that surveys will soon be commenced for this line from Waco to Rogers, Tex. T. M. Costello, Waco, Tex.

Rocky Mountain and Pacific.—Existing Roads.

BUTTE, ANACONDA & PACIFIC.—Very satisfactory progress is being made on the construction of this railway from Butte City, Mont., to the Anaconda smelters, 20 miles. The grading and bridgework is well advanced and ties are being distributed for trackiaying.

CALIFORNIA & NORTHEASTERN.—The Red Cross Lumber Mill Co., of San Francisco, Cal., is building this railway to open up timber lands in Shasta and Siskiyou counties. The road is projected to run from Castle Crag, Shasta Co., Cal., to Bartles, Siskiyou Co., and thence north to Klamath Falls, Ore. The 30 miles from Castle Crag to Bartles have been surveyed, about 5 miles completed and 10 miles to be constructed this year.

ROGUE RIVER VALLEY.—Surveys will probably soon begin for an extension to Klamath Falls, Ore., 60 miles. Pres., W. Honeyman, Portland, Ore.

WESTERN CONSTRUCTION CO.—This company has been chartered in Iowa to build the 145 miles of the Santa Fe, Prescott & Phoenix R. R. in Arizona between Prescott and Phoenix. The first 55 miles of the road from Ash Fork on the Atlantic & Pacific to Prescott is now nearly completed, Langtry Brothers, of Topeka, being the contractors. After leaving Prescott there is some very heavy work in the Bradshaw mountains, the line circling to the west around Antelope peak, through People's Valley, and passing the Senator, Congress and other rich mines, and it is this division the new company expects to build. The Congress mine is owned by the Diamond Joe Reynolds estate, which is the principal stockholder in the new road. D. R. Robinson is president of the road, and Frank Murphy, of Prescott, superintendent of the Congress mine, is secretary. The Western Construction Co. expects to complete the line into Phoenix by January, 1894, as much of the roadbed after leaving the mountains on the border of the Salt River valley is already graded.

DENVER & RIO GRANDE.—There is a prospect that this company will construct a line from Tres Piedras to the new mining camp of Rio Hondo. Ch. Engr., M. H. Rogers, Denver, Colo.

Projects and Surveys.

BOISE RY. & TERMINAL CO.—Incorporated in Idaho to build a bridge across the Boise River and extend the Union Pacific into the city. D. E. Colvin and D. C. Lockwood, of Pocatello, Idaho, are two of the incorporators.

LOS ANGELES, OWENS VALLEY & UTAH.—Chartered in California to build a standard gage railway.

ELECTRIC RAILWAYS.

SYRACUSE, N. Y.—Mr. C. Loomis Allen informs us that surveys are in progress for 3¼ miles of double track and extensions of electric road for the Consolidated Street Ry Co., from West St. to the end of the present single track, near the works of the Solvay Process Co. Some alterations are being made in the route to avoid two crossings of the New York Central & Hudson River R. R. Mather & Allen, of Syracuse, are making the surveys.

GETTYSBURG, PA.—The directors of the Gettysburg Electric R. R. have awarded the contract for building the road to Duerr & Co., of Philadelphia. The line will be eight miles in length, and extend down the Baltimore Pike to Culp's Hill, thence westward to Hancock Ave., along it to Round Top, and then back to town via the Emmitsburg road. The line will be ready for travel by July 1.

WINTON, PA.—Chartered, Mt. Vernon Electric St. Ry. Co.; capital stock, $24,000.

MARTINSVILLE, IND.—Surveys will soon begin for the electric railway to Indianapolis. H. A. Smock, Oscar Matthews, John Hardwick.

CHARLESTON, S. C.—A controlling interest in the Enterprise St. R. R. Co. will probably be secured by the Great Western Electrical Manufacturing Co., and electricity adopted as the motive power.

SPRINGFIELD, ILL.—Chartered, Springfield Consolidated Ry. Co.; to operated horse, dummy and electric railways; capital stock, $750,000; incorporators, Charles K. Minary, of Louisville, Ky., and Bluford Wilson and Frank H. Jones, of Springfield, Ill.

HORSE AND MOTOR RAILWAYS.

PITTSBURG, PA.—Chartered, Sheridan Terrace Passenger Ry. Co.; Pittsburg to Sheridan Terrace; capital stock, $12,000; Pres., Clifford B. Harmon.

WILLIAMSPORT, PA.—Chartered, Hollywood & Grand View Passenger Ry. Co.; Hollywood to Grand View; capital stock, $24,000; Pres., S. Q. Mingle.—Newberry Passenger Ry. Co.; Williamsport to Newberry; capital stock, $18,000; Pres., John Lawshe.—Union Passenger Ry. Co.; capital stock, $30,000; Treas., John Lawshe.

BRIDGES, TUNNELS AND CANALS.

MONTREAL, QUE.—Plans are being prepared for a bridge over the Grand Trunk Ry. tracks at Mountain St., to cost $80,000.

BUFFALO, N. Y.—The South Kensington Land Co. will build a stone bridge over Scajaquada Creek.

TONAWANDA, N. Y.—The governor has signed the bill appropriating $50,000 for a stone bridge over the Erie Canal at this place.

BALTIMORE, MD.—The South Baltimore Brick & Tile Co. ask permission to build a toll bridge from Meeters' Point to the Light St. Bridge.

SIOUX CITY, IA.—The Missouri River Bridge Co. has been incorporated with a capital stock of $2,500,000. The company is composed of James O. Pease, Sidney A. and Wm. R. Wright, of Philadelphia, and A. S. Garrettson, F. C. Mills, and others of Sioux City. The company has purchased the works and franchises of the Pacific Short Line Bridge Co., now constructing a combination railway and wagon bridge across the Missouri River here, and will complete it.

TACOMA, WASH.—We are informed by James M. Morrison that at an election April 11 the city will vote on proposition to issue bonds for $120,750 for a bridge across ship canal.

HIGHWAYS.

NEW YORK.—The trustees of White Plains have amended the village charter so that hereafter they will be empowered to raise 2% of the total assessed valuation annually for the improvement of the roads. This will give them about $30,000 each year to expend for this purpose.

INDIANA.—The commissioners of Marion county are preparing specifications for advertising for bids for repairs to the free gravel roads of the county. There are about 75 roads, with a total length of 300 miles, which are reported to cost about $100 per mile to keep in repair.

WATER-WORKS.

New England.

BRUNSWICK, ME.—A committee has been appointed to receive plans and proposals for a system of sewers. T. H. Riley, Vill. Clk.

YORK, ME.—Surveys for works have been made, it is reported.

ESSEX JUNCTION, VT.—It is reported that the contract for the water-works to supply the new military post, Fort Ethan Allen, has been or will be awarded to Ziegler & Dalton, Junction City, Kan., for $18,889.

ROCHESTER, N. H.—The committee on sewerage has been authorized to contract for the completion of the proposed sewerage system, and to employ the necessary superintendents and engineers.

MEDFORD, MASS.—Engr. M. M. Tidd, Boston, has been engaged to prepare plans for an additional supply from driven wells. The present works will be connected by an 8-in. main with the Mystic division of the Boston water-works, for an emergency supply. The legislature has authorized the issuance of $300,000 of bonds for a new supply.

METHUEN, MASS.—The town has bought the rights and property of the Methuen Water Co. for about $1,100, and will probably build the works projected by the company.

ROCKPORT, MASS.—The town has voted to build works and elected Geo. I. Tarr, Geo. A. Lowe and J. Loring Woodfall, commissioners. The Rockport Water Co. has been seeking incorporation.

TAUNTON, MASS.—The aldermen have voted $16,000 for 2,100 ft. of 16-in. pipe to replace 6-in.

WOODBURY, CONN.—A company may be incorporated.

Middle.

BLISS, N. Y.—It is reported that works are to be built at a cost of $18,000, and that Geo. Cowan, Stamford, is interested.

BATAVIA, N. Y.—There is some talk, merely, of filtration of Tonawanda Creek water.

BINGHAMTON, N. Y.—It is reported that the water commissioners estimate that a 6,000,000-gallon filtering plant could be put in for less than $50,000.

DUANESBURGH, N. Y.—The Duanesburgh Water Co. has begun to build a reservoir to supply Delanson and the Delaware & Hudson Canal Co.

DOWNSVILLE, N. Y.—Works are talked of.

LOWVILLE, N. Y.—A committee has reported that gravity works could be built for about $70,000. An election may be held May 1 to vote on the subject. Engr. W. B. Rider, South Norwalk, has reported on the project.

MORRIS, N. Y.—It is stated that works may be built by Wm. Cowan, Stamford.

POTSDAM, N. Y.—Filtration is being discussed.

RICHMONDVILLE, N. Y.—A franchise has been granted Wm. Cowan & Co., Stamford. There will be 18 hydrants at a yearly rental of $750.

WYOMING, N. Y.—Works are under discussion.

IRVINGTON, N. J.—A citizens' meeting has voted to request the new town trustees to give a franchise to the Irvington Water Co.

NEW BRUNSWICK, N. J.—The water commissioners propose to lay a new 20-in. force main at once. It is stated that Supt. C. H. Cramer has been authorized to buy 400 to 500 tons of pipe. The new main will replace a 12-in. cement lined pipe said to have been in use 25 years. There is a duplicate force main.

CORAOPOLIS, PA.—Works to be owned by the town are talked of. A company secured a charter some years ago to supply this place, but it is claimed that the charter has become void.

MAHANOY CITY, PA.—Bids are wanted by the water commissioners until April 18 for furnishing material and building works. There will be a dam, pumping station, reservoir and about nine miles of mains. A company now supplies the city. Marshall J. Young, Easton, Engr.; Frederick Miller, Edw. Gorman and R. T. Lewis, Comrs.

MANSFIELD, PA.—There is talk of introducing a supply from the reservoir which supplies Blossburg reservoir and also from Seeley Creek.

NEWPORT, PA.—It is reported that a franchise has been granted and a contract made for 24 hydrants, at a yearly rental of $600; also that an application for a charter will be made.

SOMERSET, PA.—Alternate bids for gravity or pumping works are wanted until May 13. W. H. Weifley, Burgess.

TOWER CITY, PA.—It is reported that a franchise has been granted to the parties who control the Millersburg and Middletown works. It is said that the franchise calls for 25 hydrants.

MIDDLETOWN, MD.—Town officers in favor of water-works have just been elected. Address G. W. Remsburg.

Southern.

PETERSBURG, VA.—The city engineer has reported on a 155,000,000-gallon reservoir; estimated cost, $30,000.

KEYSER, W. VA.—Preliminary surveys for gravity works have been made by Engr. A. G. Adsberger, Baltimore.

DEMOPOLIS, ALA.—It is reported that works will soon be built.

DOTHEN, ALA.—It is stated that the city intends to build works.

OZARK, ALA.—It is reported that the council proposes to lease the city works.

GREENVILLE, MISS.—Bids for a franchise are wanted, as stated in our advertising columns.

FAYETTEVILLE, TENN.—The "Observer" is discussing works.

HARRIMAN, TENN.—The aldermen have passed an ordinance providing for the issuance of $50,000 of 6%, 10-30, gold water bonds.

HOPKINSVILLE, KY.—A decision in favor of the city has been rendered in the circuit court. It is stated that works will be established.

SHELBYVILLE, KY.—Both branches of the legislature have passed a bill, which permits the city to contract for works.

North Central.

GALLIPOLIS, O.—It is reported that the town has voted $85,000 for works.

PORTSMOUTH, O.—We are informed by R. A. Bryan, Cy. Engr., that bids will be opened May 16 for 7,300 lin. ft. of 2½ to 5-ft. brick sewers, average cut 8 ft., and 11,046 lin. ft. of 1 to 2-ft. pipe sewers, average cut 9 ft.; estimated cost, $35,000.

READING, O.—Bids are wanted until April 18 for two 5×16-ft. tubular boilers in place, with all appurtenances; also for a 12×30-in. automatic cut-off steam engine and a duplex pump, both in place. A. G. Aukenbauer, Clk.

MARTINSVILLE, IND.—The town has contracted with the Addyston Pipe & Steel Co., Addyston, O., for about 400 tons of 4, 6, 8 and 10-in. cast iron pipe at $23.50 per ton.

NORTH MANCHESTER, IND.—Bids for constructing works are wanted, as stated in our advertising columns.

ROCHESTER, IND.—Bids for constructing works are wanted until April 25, as stated in detail in our advertising columns last week.

ROCKVILLE, IND.—The people will vote on putting in works.

TIPTON, IND.—May 2 the people will vote on building works.

HARTFORD, MICH.—The people are talking of damming the Paw Paw River to obtain power for works.

CENTRALIA, ILL.—Bids for constructing works are wanted by the city until April 26. I. A. Smith, Consult. Engr. and Supt., St. Louis, Mo.; J. N. Kerr, Mayor; W. F. Bundy, Cy. Clk.

KANKAUNA, WIS.—The council has recommended that the incoming council accept the bid for a franchise made by the Moffett, Hodgkins & Clarke Co., New York city.

SOUTH MILWAUKEE, WIS.—It is reported that a franchise has been granted to C. E. Gray & Co., Whitewater.

Northwestern.

MAQUOKETA, IA.—Meters will be put in on services to large consumers.

CHANUTE, KAN.—The people have voted, 528 to 19, for the issuance of $50,000 of bonds for works.

OAKLEY, KAN.—Bonds to the amount of $6,000 have been voted for works.

WASHINGTON, KAN.—Bonds for works have been voted. Bids for the works were published in our issue of March 23.

FARGO, N. DAK.—We are informed by J. Tudor Graves, Cy. Engr., that bids will be received until May 8 for the following sewers: 24-in., 1,620 ft.; 18-in., 1,168 ft.; 15-in., 800 ft.; 15-in., relaid, 1,100 ft.; 12-in., 1,300 ft.; 9-in., 750 ft.; 6-in., 98 ft. A further extension is under consideration.

Southwestern.

GALVESTON, TEX.—Chf. Engr. W. Kiersted has reported in detail upon the proposed new supply from a series of wells on the mainland about 3¾ miles west of Hitchcock. A 30-in. cast iron force main, 96,714 ft., or about 18 miles, long, is recommended, the pipe to be laid at the bottom of the bay, in crossing, on hard ground. Low-lift vertical pumping engines are recommended at the wells, and a covered masonry storage reservoir in the city. The estimated cost of the works is $908,575.

EAST LAS VEGAS, N. MEX.—The council has granted a 25-years' franchise to Henry S. Raymond, Chicago, which provides for eight miles of mains and 80 hydrants, at an annual rental of $4,200; water for public buildings, churches, street sprinkling, park irrigation, and one fountain, to be furnished without charge. The works must be completed by July 1, 1894.

Pacific.

CHARLESTON, WASH.—It is reported that Seattle parties have formed a company to build works here, and that surveys will be made by L. T. Merry.

CHEHALIS, WASH.—The company is considering the advisability of changing its source of supply from the Mewaukum to the Chehalis River. The water is now conveyed to the city through a 7-mile flume.

NORTHPORT, WASH.—Mr. R. Galusha, of Galusha & Liftchild, general agents for the Northport Townsite Co., state that the company will put in works this spring.

WASHOUGAL, WASH.—The Washougal Flume, Water, & Improvement Co. has been incorporated; $100,000.

WENATCHEE, WASH.—Works are proposed. W. R. Prowell, Clk.

LOS ANGELES, CAL.—The Alimitos Beach Water Co. has been incorporated; $187,000, of which $625 has been subscribed; Jotham Bixby, Long Beach; H. W. Hellman, Los Angeles; I. W. Hellman, San Francisco.

Canada.

VANCOUVER, B. C.—Bids are wanted until May 6 for supplying 92 lengths of 12-in. cast iron pipe, with flexible joints, for a submerged main. T. F. McGuigan, Cy. Clk.

IRRIGATION.

NEW COMPANIES.—Nebraska Irrigation & Water Power Co., York, Neb.; $50,000; Geo. R. Reed and Robert Armstrong are interested. Texas Irrigation Co., Pecos City, Tex.; $10,000; W. C. Mann, Eddy, N. Mex.; Homer and Agnes Powers, Pecos City. Kean Canal Co., Lamar, Colo.; $100,000. Rio Mimbres Irrigation Co., Chicago, Ill., and Mimbres Valley, N. Mex.; $300,000; Lucius G. Fisher, Albert G. Spaiding and Frederick Ullman, Chicago.

SEWERS.

GARDINER, ME.—We are informed by J. B. Dingley, Mayor, that plans have been prepared by F. Danforth for a system of 6 to 12-in. pipe sewers. The city council is considering an appropriation of $10,000 for the construction.

CHELSEA, MASS.—Sewer extensions have been authorized at an estimated cost of $5,000; total length, 4,500 ft.

WALTHAM, MASS.—The contract for a pipe sewer in Linden St. has been awarded to W. A. Cole, Waltham, at $12,400.

WESTFIELD, MASS.—An appropriation of $15,000 has been voted for extending the sewer system.

BROOKLYN, N. Y.—Bids will be received until April 19 for a main sewer in Twentieth Ave., town of New Utrecht. C. Furgueson, Jr., Garfield Building.

CAMDEN, N. Y.—A special election will be held April 15, to vote on the question of a sewer system; estimated cost, $10,000 to $15,000.

MATTEAWAN, N. Y.—The legislature has appropriated $15,000 for a sewer from the State Asylum for Insane Criminals to the Hudson River. The work will be done by the state.

SARATOGA SPRINGS, N. Y.—The board of trustees will receive bids until April 20 for a pipe sewer in North St.

TROY, N. Y.—The board of contract will receive bids until April 18 for a pipe sewer and until April 21 for a brick sewer.

NEW BRUNSWICK, N. J.—The city engineer will receive bids until April 17 for 2,100 ft. of 24-in. sewer, average cut 9.5 ft., and 495 ft. of 20-in., average cut 7.3 ft.

MOORESTOWN, N. J.—The town committee has recommended a system of sewers to cost $40,000 to $50,000.

OCEAN CITY, N. J.—It is reported that a sewerage system is to be constructed.

PHILADELPHIA, PA.—Of the appropriation of $400,000 for main sewers, $225,000 is for work in Germantown, ward 22. Construction on these will begin at once.

BALTIMORE, MD.—The ordinance for a sewer in Fort Ave. to cost $66,000, has been signed.

CHARLOTTESVILLE, VA.—We are informed by G. W. Spooner, Cy. Engr., that plans are being prepared by Rudolph Hering for a system to be about 18 miles in length.

MERIDIAN, MISS.—The city is reported as about to award contracts for a sewerage system. Samuel M. Gray, Providence, R. I., was engaged to prepare plans, as noted in our issue of Feb. 23. N. M. Brandon, Cy. Engr.

ASHTABULA, O.—The city clerk will receive bids until April 22 for sewers in two streets.

CHILLICOTHE, O.—The board of trade is agitating the question of a sewerage system.

LOCKLAND, O.—At the election last week the vote was 152 to 92 in favor of sewers.

MARTIN'S FERRY, O.—Richard F. Allender, Cy. Clk., informs us that Alexander Potter, New York, has been engaged by the city to make plans, profiles, specifications and estimates for a complete system of sewers. The system will be designed to take care of storm water.

HAMMOND, IND.—The city engineer is preparing plans for proposed sewers. Improvements to cost $100,000 are being considered.

DETROIT, MICH.—Contracts for sewers have been awarded as follows: John Affeld, 2,120 lin. ft., at $4.08 per lin. ft., and six manholes, at $30 each; Jeynes & Rauk, 2,101 lin. ft., at $3.10, and manholes at $30; J. H. Stone, 2,805 lin. ft., at $3.28, and manholes at $35.

MARINETTE, WIS.—E. L. Shaw, Cy. Engr., informs us that the city has voted to issue bonds for $60,000 for sewers, and that the work will be let in a short time.

KANSAS CITY, MO.—No bids were received April 3 for the Gooseneck Creek sewer, estimated to cost $60,000.

FORT DODGE, KAN.—The question of sewerage is being discussed, and it is thought that bids will soon be asked for the work.

BOULDER, COLO.—We are informed by Geo. W. Teal, Cy. Engr., that the proposed system will have about 8 miles of 8-in. pipe, average cut 9 ft., and cost $25,000, but that the question of bonds has not yet been voted upon.

OAKLAND, CAL.—An election will be held April 22 in the Piedmont district to vote on the proposed sewer system.

OTTAWA, ONT.—Plans have been prepared by the city engineer and adopted by the board of works for a sewer 5,400 ft. long, to cost $25,000, and for a brick sewer to cost $140,000.

STREETS.

BURLINGTON, VT.—Capt. Pond, U. S. Engineer Office, Plattsburg, N. Y., opened 30 bids for building Fort Ethan Allen, near this city. The contract for macadam roads at the fort is reported as awarded to Flood & Sherrill, Sandy Hill, N. Y., at $18,396.

BOSTON, MASS.—The superintendent of streets will receive bids until April 20 for a telford road in Commonwealth Ave., from Beacon St. to Granby Ave.

WORCESTER, MASS.—Bids will be received at the office of the city engineer until April 18 for 12,000 sq. yds. brick paving, 700 sq. yds. brick paving on edge, 8,000 sq. yds. gutter and crosswalk cobble paving, 18,000 lin. ft. curbstone, 500 lin. ft. circular curbstone, 2,500 lin. ft. 18×24-in. flagstone, 14,000 sq. yds. block paving, etc.

BRISTOL, R. I.—The town clerk will receive bids until April 15 for 1,000 lin. ft. of macadamizing in Hope St.

PROVIDENCE, R. I.—The council has ordered the paving of several streets, and voted to issue city notes for $500,000, at 6%, for highways.

ALBANY, N. Y.—The board of contract will receive bids until April 17 for paving one street with dimension granite blocks. Ordinances have been passed for paving several additional streets.

NEW YORK, N. Y.—Bids will be received until April 25 for three contracts for trap rock screenings, grading and paving with granite blocks in wards 23 and 24.

TROY, N. Y.—The board of contract will receive bids until April 18 for paving two streets with granite blocks.

CAPE MAY, N. J.—The city council has voted to pave in Washington St. as an experiment. The total appropriations for the year amount to $41,635.

BRADDOCK, PA.—An ordinance has been passed providing $100,000 for street improvements. Bids will be received by the borough clerk until April 17 for paving three streets and two alleys with brick.

JENKINTOWN, PA.—The court has authorized the proposed increase of the borough debt $30,000 to macadamize the streets.

WILLIAMSPORT, PA.—The city engineer estimates that the city's proportion of the proposed paving of Fourth St. with Belgian blocks, at $5 per sq. yd., would be $54,000. The kind of pavement has not been definitely decided upon.

ATLANTA, GA.—Paving with Belgian blocks has been ordered, estimated to cost $26,100.

ASHTABULA, O.—The city clerk will receive bids until May 6 for paving Main St.

CHILLOCOTHE, O.—The city council is considering the question of street paving.

CLEVELAND, O.—The director of public works will receive bids until April 19 for paving in four streets with Medina stone, and until May 3 for paving in eight streets with Medina stone and in four with brick.

DAYTON, O.—The city comptroller will receive bids until April 24 for about 90,000 sq. yds. of paving with Medina blocks, Hayden blocks, Hallwood blocks, asphalt, or brick.

ELMWOOD PLACE, O.—Bids will be received until April 25 for cement sidewalks. A. C. Kaylor, Chn. Com.

TIFFIN, O.—The city clerk will receive bids until April 29 for paving Perry St. with brick.

SAGINAW, MICH.—Sapless cedar blocks have been selected as the material for the proposed paving of Washington Ave.

EVANSTOWN, ILL.—The city clerk will receive bids until April 17 for paving Davis St. with brick.

OTTUMWA, IA.—The street committee will receive bids until April 17 for paving with brick in three districts.

TACOMA, WASH.—We are informed by James M. Morrison, Cy. Engr., that bids will be opened about May 1 for 20,854 sq. yds. paving with bituminous rock, 4,850 lin. ft. granite curbing, 4,410 cu. yds. grading; estimated cost, $70,000; and for 26,778 sq. yds. paving with wooden blocks, 4,668 lin. ft. granite curbing, 6,777 cu. yds. grading; estimated cost, $72,000.

ELECTRICAL.

DUNKIRK, N. Y.—Ex-Mayor Martin has petitioned for a franchise for an incandescent electric light plant.

FLUSHING, N. Y.—Bids will be received until June 6 for street lighting. G. A. Roullier, Village Engr.

GENESEO, N. Y.—A public vote will be taken April 20 on the question of electric lights.

HICKORY, N. C.—It is reported that M. E. Thornton and others will erect an electric power plant on the Catawaba River, 2½ miles distant.

NASHVILLE, TENN.—The board of public works has recommended that the contract for street lighting be awarded to the Cumberland Electric Light & Power Co., at 26 cts. per light per night for the first two years and at a price not to exceed 25 cts. per light per night for such a time as the contract shall run over two years. Bids were received for a contract for five years.

WINCHESTER, KY.—The mayor desires bids for lighting the city; population, 6,000.

AKRON, O.—The contract for electric street lights for five years has been awarded to the Akron General Electric Co., at three cents per light per hour for all dark hours, or an estimated cost of $75 per light per year.

MEDINA, O.—The question of issuing bonds for an electric light plant was defeated April 3.

WENATCHEE, WASH.—We are informed by W. R. Prowell, Cy. Clk., that a plant for 20 arc and 200 incandescent lights is proposed, the estimated cost being $12,000.

CONTRACT PRICES.

PIPE.—Manchester, N. H.—The contracts for 25,000 tons of iron pipe has been awarded by the water commissioners to the Warren Foundry & Machine Co., Phillipsburgh, N. J., at $26.00 per ton. There were four bids received ranging from $26.60 to $26.90 per ton.

WATER-WORKS SUPPLIES.—Richmond, Va.—We have received from E. E. Davis, Secy. Com. on Water, a statement of the bids received March 30, contracts having been awarded as follows: West & Branch, Chapman fire hydrants, at $22.35; Smith Courtney Co., Ludlow valves, 4, 6, 8, 10, 12, 16 and 20-in., at $7, $11.30, $17.50, $26.50, $32.50, $63 and $105; also pig lead at $4.45, and wiping solder at $12.25 per 100 lbs. The bids for pipe ranged as follows: 3-in., $25.75 to $30.50 per ton of 2,240 lbs.; 4-in., $25.25 to $27.90; 6-in., $24.75 to $26.75; 8, 10 and 12-in., $24.25 to $26.64; specials, 2.1 to 2.5 cts. per lb.

PAVING BRICK.—Boston, Mass.—The following bids were received by the superintendent of streets for 300,000 paving brick: Ham & Carter, 100,000 on wharves, at $12; 100,000 delivered on streets at $13; 100,000 delivered on streets of Roxbury, at $13.50; East Kingston Brick Co., $14.50, $11.50, $12; Payson & Co., $15 for each; New England Steam Brick Co., $13.75 for each.

SEWERS.—Peoria, Ill.—Geo. F. Wightman, Cy. Engr., informs us that the following bids were received April 1 for sewers in district No. 6: 1, Muir & Nicholson, $54,894; 2, Robt. Clark, $54,003; 3, Rockford Construction Co., $52,926.

	1.	2.	3.
60-in. brick sewer, per lin. ft...	$6.50	$5.50	$5.00
54-in. " " " " ...	6.00	5.00	4.60
36-in. " " " " ...	4.00	4.00	3.30
24-in. " " " " ...	3.10	3.00	2.80
18-in. pipe " " " ...	1.30	1.50	1.44
15-in. " " " " ...	1.05	1.30	1.20
12-in. " " " " ...	1.00	.95	1.04
Catchbasins, each.....	55.00	50.00	40.00
Manholes, "	55.00	35.00	35.00
Lampholes "	12.00	10.00	10.00

Indianapolis, Ind.—The contract for a sewer in 14th St. has been awarded to Fulmer & Selbert, at $17.97 per lin. ft.; size, 8×12½ ft. to 5½-ft. diameter; length, 11,155 ft. Other awards were made as follows: Gansberg & Roney, 2,432 lin. ft., 1½×2¼ ft. to 2 1-6×3¼ ft., at $2.49; 1,975 lin. ft., 2½×3½ ft. to 15-in., at $2.48; Wm. Bossert, 1,466 lin. ft., 1⅞×2½ ft. to 8-in., at $1.89.

Montclair, N. J.—The contracts for sections No. 1 and No. 2 of the sewer system, have been awarded as follows, the prices in the first column being those of H. P. McTague, Mount Vernon, the successful bidder for section No. 1, and those in the second column those of T. J. Regan & Co., Newark, successful bidders for section No. 2:

	1.	2.
24-in. pipe, per lin. ft.....	....	$2.60
Y's in same	....	1.00
20-in. pipe, per lin. ft.....	....	2.29
Y's in same.....	....	2.00
15-in. pipe, per lin. ft.....	....	1.07
Y's in same.....	....	1.25
12-in. pipe, per lin. ft.....	$ .80	....
Y's in same.....	.75	....
10-in. pipe, per lin. ft.....	.75	.61
Y's in same.....	.60	.50
8-in. pipe, per lin. ft.....	.50	.50
Y's in same.....	.40	.25
Manholes, per vert. ft., under 12 ft...	3.00	2.00
" " " over " ..	3.25	2.50
Flush tanks, each.....	50.00	75.00
Lamp holes, per vert. ft.....	1.00	1.00
Concrete, per cu. yd.....	4.00	6.00
Rock excavation, per cu. yd.....	2.00	3.00
Iron castings, per lb.....	.02½	.02½
Iron pipe, per gross ton.....	30.00	54.00
Timber foundations, per 1,000 ft.....	10.00	25.00
Hemlock sheathing, " " ...	10.00	20.00
Spruce " " " ...	10.00	27.00
Excavation below grade, per cu. yd..	.60	1.00
4-in. tile, per ft.....	.10	1.00
6 " "	.12	1.00
Drops in manholes, per vertical ft....	2.00	5.00

ASPHALT AND STONE BLOCKS.—Salt Lake City, Utah.—The contract for paving West Temple St. has been awarded to the Pacific Paving Co., as noted last week, the bidders being as follows: 1, Pacific Paving Co.; 2, Culmer-Jennings Paving Co.; 3, Ryan & Griffin.

	1.	2.	3
Curbing, 5,000 lin. ft., at.....	$1.00	$1.08	$1.15
Flagstone, 6,000 sq. ft., at.....	.73	.68	1.50
Paving with stone blocks, 6,000 sq. yds., at.....	3.15	3.22	2.85
Paving with asphalt, 15,000 sq. yds., at.....	2.97	3.19	3.25
Paving with bituminous rock, 15,000 sq. yds., at.....	....	....	3.00

BRICK PAVING.—Pensacola, Fla.—We are informed by E. E. Moore, Engr. in charge, that the Southern Construction Co. has been awarded a contract for paving 12,000 sq. yds. with brick, at $2.44 per sq. yd.

ROADS, ETC.—New York, N. Y.—The contract for the construction of highways and their appurtenances at reservoir 11, in the town of Carmel, has been awarded by the aqueduct commissioners to Peter J. Moran, at $88,389, the other total bids being as follows: Washburn & Washburn, $94,507; Clinton Stephens, $97,520; Troy Public Works Co., $98,705; John Twiname, $102,327; J. C. Rodgers, $110,920; O'Connor & Overman, $126,374; Sareno Gallo & Joab Small, $127,546. The engineer's estimate was $109,839.75. We print below the itemized bid of Mr. Moran and in the second column the engineer's estimate:

	1.	2.
Earth excavation, 130,000 cu. yds., at...	$ .20	$ .30
Rock excavation, 400 cu. yds., at.....	2.50	1.50
Rip-rap, 25,000 cu. yds., at.....	1.00	1.75
Rubble masonry, in mortar, 1,500 cu. yds., at.....	4.00	4.50
Rubble masonry, laid dry, 2,300 cu. yds. at.....	2.00	3.00
Split-stone masonry, 200 cu. yds., at..	3.50	8.00
Dimension stone masonry, 25 cu. yds., at..	15.00	40.00
Brick masonry, 370 cu. yds., at.....	10.00	10.00
Concrete, 5 to 1, 165 cu. yds., at.....	5.00	4.50
Additional for masonry in Portland cement, 50 cu. yds., at.....	2.00	1.00
"Six-cut" face dressing, 25 sq. ft., at...	1.00	.75
Rough point face dressing, 25 sq. ft., at.	.40	.50
Face work for rubble, 200 sq. ft., at....	.25	.25
White pine timber, placed, 1,000 ft., B. M., at.....	50.00	45.00
White oak or chestnut timber, placed, 2,400 ft., B. M., at.....	60.00	50.00
Hemlock timber, placed, 1,000 ft., B. M., at.....	30.00	30.00
15-in. tile drain pipe, laid, 120 lin. ft., at.	1.50	1.50
Stone wall fencing, 5,800 lin. ft., at..	1.25	.80
Post and rail fencing, 600 lin. ft., at..	.50	.25
Superstructure for bridge, 1 bridge, at..	350.00	500.00

MISCELLANEOUS.

GARBAGE CREMATORS.—San Antonio, Tex.—The city council has appropriated $13,000 for two garbage cremators.

PIERWORK AND DREDGING.—New York, N. Y.—The department of docks will receive bids until April 26 for the removal of the outer portion of pier old 62, and about 15,000 cu. yds. of dredging over the site of same.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Schenectady Locomotive Works, Schenectady, N. Y., have orders for 11 freight engines for the Southern Pacific, and 5 ten-wheel engines for the Central Vermont. The Rhode Island Locomotive Works, Providence, R. I., have an order for 10 tank engines for the Lake St. Elevated, Chicago. The Richmond Locomotive Works, Richmond, Va., are building 2 eight-wheel passenger engines and 5 six-wheel switching engines for the Chesapeake & Ohio; one of the eight-wheel engines will be exhibited at the World's Columbian Exposition. The Baldwin Locomotive Works, Philadelphia, Pa., have an order from the Ohio Southern for 8 eight-wheel passenger engines, with cylinders 19×24 ins., for the new line from Springfield to Lima; the works have delivered 2 switching engines to the same road.

CARS.—The Michigan Peninsula Car Co., Detroit, Mich., has an order for 2,000 gondola cars of 60,000 lbs. capacity for the Ohio Southern. The Ohio Falls Car Co., Jeffersonville, Ind., has built two trains of vestibule cars for the Louisville, Evansville & St. Louis, and has orders from the Ohio Southern for 1,500 box cars and 500 gondola cars of 60,000 lbs. capacity, 10 passenger cars and 1 mail car. The Mt. Vernon Car Mfg. Co., Mt. Vernon, Ill., has orders for 300 box cars for the Louisville & Nashville, 500 box cars for the Illinois Central and 300 flat cars for the Monterey & Mexican Gulf. The Allison Mfg. Co., Philadelphia, Pa., is building a number of the O'Connor dump cars illustrated in our issue of Feb. 2, 1893. The Illinois Central will add to its equipment 100 passenger cars, 100 suburban cars and 100 cars for the World's Columbian Exposition, the latter convertible to refrigerator fruit cars, as illustrated and described in our issue of Nov. 17, 1892.

TURNTABLE.—The Greenleaf Turntable Co. has an order for a 60-ft. turntable of 100 tons capacity for the Evansville & Terre Haute, to be placed at Evansville, Ind.

THE WESTINGHOUSE AIR BRAKE CO. AND AMERICAN BRAKE CO. have removed their New York office from No. 160 Broadway to the Havemeyer Building.

CITY OF CAMBRIDGE.

TO BRIDGE BUILDERS.—HIGHWAY BRIDGE.

Sealed proposals will be received at the office of the Cambridge Water Board, City Hall, Cambridge, Mass., until 4:30 o'clock p. m. of Wednesday, April 26, 1893, for the construction and erection of a wrought iron and steel highway bridge over the location of the pipe line near Fresh Pond, at Fresh Pond Avenue, Cambridge.

The bridge to be seventy-five (75) feet in length, and fifty-eight (58) feet in width between the railings.

Plans and specifications can be seen and any information obtained at the office of the City Engineer, City Hall, Cambridge.

Each bid must be signed by the full business name and address of the bidder, and be accompanied by a certified check in the sum of five hundred (500) dollars, payable to the order of the City of Cambridge, which check will be returned unless forfeited, as specified in the printed form of proposal. A satisfactory bond will be required of the successful bidder.

The right is reserved to reject any or all bids received.

Bids should be marked, "Proposal for Fresh Pond Avenue Bridge," and addressed to the "Cambridge Water Board," Cambridge, Mass.

L. M. HASTINGS,
City Engineer.

Cambridge, April 15th, 1893. 15-1t

PROPOSALS FOR NEW WATER SUPPLY.—Sealed proposals will be received at the office of the Board of Commissioners of Water-Works of the city of Galveston, Tex., until twelve (12) o'clock, m., of the 8th day of May, 1893, for furnishing the city of Galveston with the material and for performing the work outlined in the following approximate amounts:

About 13,117 tons of 2,000 pounds of 30-inch cast iron water pipe.

About 2,177 tons of 2,000 pounds of 30-inch special cast iron water pipe for submerged pipe line.

About 33 tons of 2,000 pounds of miscellaneous cast iron pipe.

About 60 tons of 2,000 pounds of assorted special casting.

About seventeen 30-inch valves; four 36-inch valves and about forty-six valves of other and smaller sizes.

One stand-pipe, 48 inches in diameter by 40 feet high.

One valve well about 18 feet by 20 feet, and 20 feet deep, with house.

One reservoir, 40 feet inside diameter; with house.

One artesian well system, guaranteed to supply 5,000,000 gallons of water per twenty-four hours.

Laying about sixteen miles of pipe on land.

Laying about two miles of 30-inch submerged pipe.

Erecting one pumping station 40 feet by 80 feet.

Furnishing and erecting on foundations two pumping engines, each of 6,000,000 gallons capacity per twenty-four hours, with boilers.

The work must be completed within twelve months from date of contract.

Printed specifications can be had from the City Clerk or Chief Engineer.

The right is reserved to reject any or all bids.

Bids to be for the whole work and for the different divisions of the work, separately, as per specifications.

Proposals must be made upon blank forms attached to specifications, and accompanied by guarantee bond and the sum of $5,000 in cash on the whole, or a proportionate amount on the different subdivisions of the work, as an evidence of good faith; said amount to be forfeited to the city on failure of bidder to enter contract.

Proposals will be indorsed "Proposal for New Water Supply," and must be addressed to A. S. NEWSON, Chairman of Joint Committee on Water Supply.

A. S. NEWSON,
ROBERT HAYES,
GEO. F. SCHNEIDER, JR.,
J. C. SMITH,
WM. REPPEN,
P. N. HARRIS,
L. SCHMIDT.
JOHN WEGNER,
Joint Committee on Water Supply.

W. KIERSTED, Engineer. 15-4t